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Electric Storage in an Edison Station.

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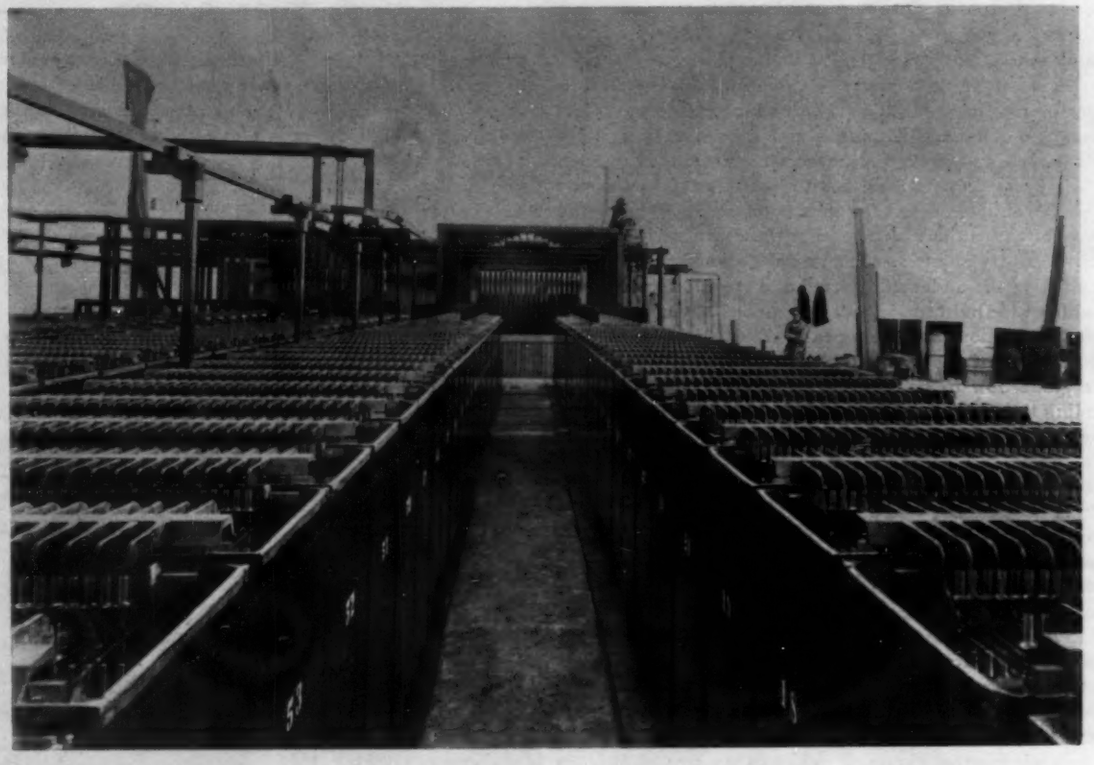
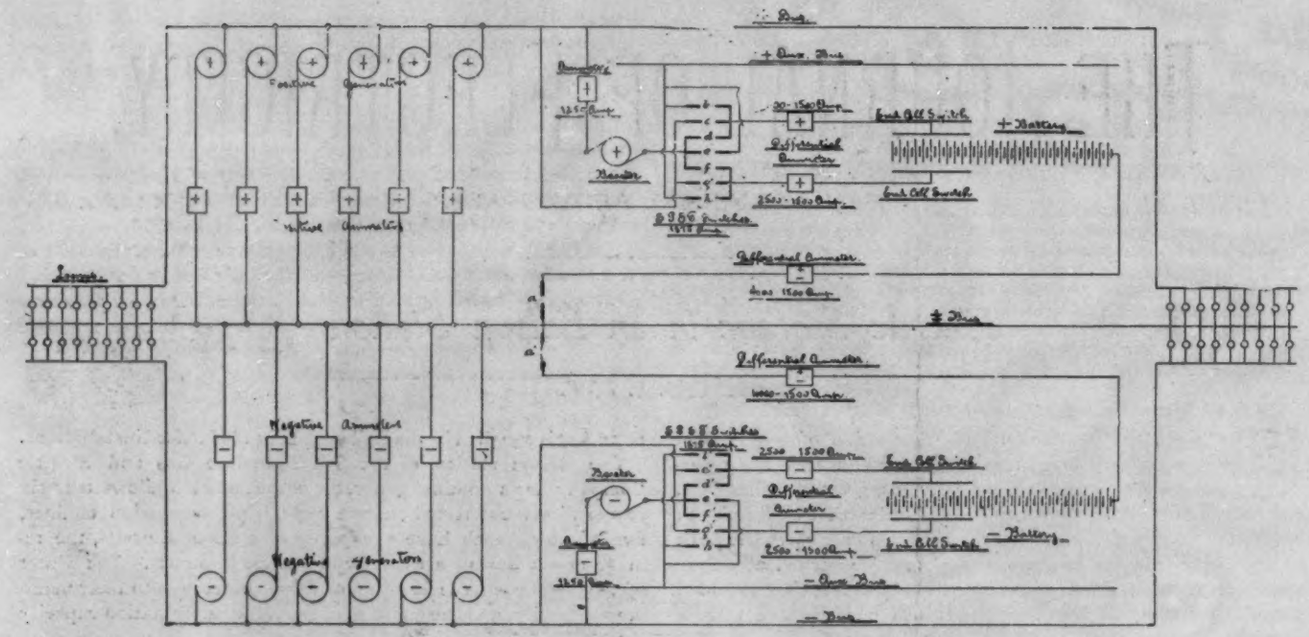
EVER since the generation and distribution of low tension electric currents for commercial incandescent lighting purposes became an established industry, great need has been felt for a means of electricity storage in order that uniformity in regulation may be secured; that the batteries may carry the peak of the load; that the engines may always be worked at a close approach to their rated capacities, thereby improving the load factor; and that, in brief, the conditions under which central stations are operated may be made to closely parallel those under which steam plants exist in driving mill loads; or, viewed again from a strictly electrical standpoint, that electricity works may be possessed of the advantages held by gas plants in the matters of generation, accumulation, and distribution. How successfully these aims have been realized will be learned from the following pages descriptive of the installation features, and the practical results obtained therefrom, of one of the most modern and complete storage battery plants ever erected in America for service in connection with a large Edison three-wire system. Moreover, its size is only exceeded by the battery of the Chicago Edison Company, but is equalled by the Philadelphia and Hartford installations.

The Edison station of the San Francisco Gas and Electric Company has a nominal generator output of 2200 kilowatts in six sets of direct connected marine type triple expansion engines, five of which each have a capacity of 2 x 200 kilowatts, the remaining set having a capacity of 2 x 100 kilowatts. The winter of 1896 witnessed the loading of these generators to their maximum capacity, and the question of providing more station capacity resolved itself into a choice between enlarging the steam and electrical equipment, or installing a storage battery without further increase in the steam plant. In either instance real estate would have to be acquired and a building erected for the enlargement of the station, and after receiving a report from its superintendent, Mr. C. O. Poole, who had been sent east to examine into the use of storage batteries in Edison stations at New York, Boston, and Philadelphia, the company determined on the installation of a battery having a capacity at least equal to the output of one of the largest steam engine sets in the Edison station at San Francisco. The plant as installed, however, is capable of delivering a



ONE HUNDRED AND FIFTY 2¼-TON "CHLORIDE" CELLS.

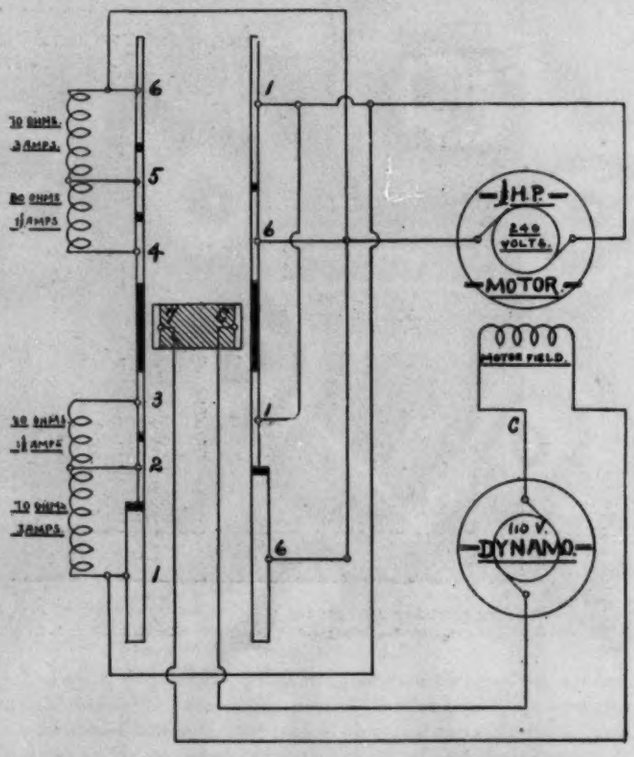
ACCUMULATORS IN THE SAN FRANCISCO EDISON STATION.



GENERAL WIRING SCHEME FOR ACCUMULATORS ON AN EDISON THREE-WIRE SYSTEM.

maximum of nearly 1000 kilowatts for an hour, which generally covers the period of the load peak. The battery was installed in the summer of 1897 in a substantial brick building 70 by 80 feet in size, erected on property adjoining and immediately north of the Edison station, and facing on Stevenson street. It is an open building, thirty-two feet in height, with notches cut in the side walls for girders and buttresses for piers upon which to build the second floor for the support of two other three-wire series of batteries when necessity requires. The roof is of wooden truss construction, oiled on the under side, tarred and graveled on top, and provided with a wide light and ventilating cupola, having swinging windows for ventilation, along the peak. The building will ultimately contain four three-wire battery installations, each of the size of the plant now to be described. Complete engineering data regarding the number, size, and characteristics of the storage cells, is appended hereto, and this, in conjunction with the accompanying diagrams, will be found to be thoroughly comprehensive.

Before entering into the very fascinating details of this beautifully working installation, it is well to point out for the benefit of those who are familiar with lines of electrical engineering other than Edison station work, that Edison generators deliver potentials approximating 110 volts to the three-wire system. In the present instance the potential delivered is 116 volts, but the oftimes great length of the underground feeders and the heavy currents carried, occasion drops in electromotive force that necessitates the raising of the pressures at the station ends of the underground feeders to close in the neighborhood of 140 volts. These increased pressures are supplied from independent or auxiliary 'bus bars whence the current is taken to the remote districts by boosted feeders direct, no light or power service whatever being taken from any of the feeders. The outlying districts are thus supplied with practically the same potential as those nearer the station. The potential of the auxiliary 'bus bar is about twenty volts above that of the main 'bus bars, and this increased pressure is derived sometimes direct from an independent set of generators running at higher voltage, but more often by the use of a combination of a three-wire motor-generator set, known by the expressive name of "booster." This consists merely of a 220-volt motor having at each end a low-volt direct connected generator, each of half the capacity of the motor, and the armatures of these generators have sufficient carrying capacity to take the whole volume of current for the auxiliary 'bus bars and raise its potential by fifty volts or so, before delivery to the auxiliary 'busses. In other words, current is taken from the main 'bus bars and run through the armatures of the booster generators, before being delivered respectively to the positive and negative auxiliary 'busses, thus making the auxiliary 'bus voltage higher than the main 'bus voltage by the value of the potential generated in the armatures of the booster generators.

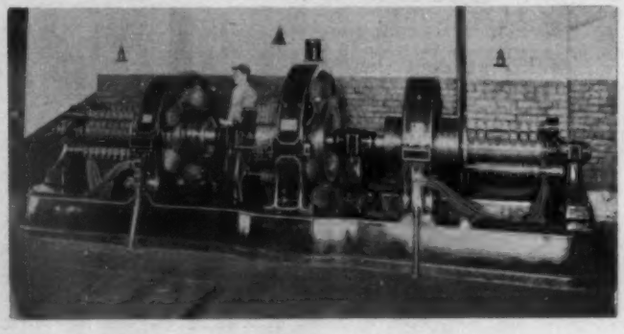


THE REGULATOR CONTROL SWITCH IN ELECTRICAL DETAIL.

The act of charging a storage battery resembles the putting of current into a shunt dynamo so as to drive it as a motor, in that when the charging generator and storage battery are at equal voltage and connected positive to positive, no current flows from one

to the other; but to get current into the dynamo to drive it as a motor, the electromotive force of the source of supply must be raised above that of the dynamo, when the latter will take current and "mote." Thus it is that the storage battery receives its charge; viz.: from a source of electricity at higher potential than that of the battery, and in practice, the amount of this excess varies; first, upon the state of the battery as to its condition of charge, and second, upon the rate of charge it is desired to give. Ordinarily, the potential used for charging that section of the battery subjected to the greatest use is about the same as that of the auxiliary 'bus bars, and should it not be so, the battery potential may be adapted to conform to that of the auxiliary 'busses by cutting in or out end cells as will be shown. Several important points are to be considered in laying out the use of a storage battery in conjunction with an Edison three-wire station. First, the batteries must be arranged so as to be worked on either the main or auxiliary 'bus bars alone or in multiple with the generators; they must be capable of either giving or taking current at all times according to fluctuations of load; they must be able to take charge at one potential and deliver current at another potential simultaneously, and they must be as readily controlled by the switchboard attendant as a generator. Two series of batteries, the positive and negative sets, are connected in across the three-wire service upon the same underlying principles as Edison generators are coupled up; each of these series consists of seventy-five cells, nineteen of which, used for regulating purposes as described, are termed the "end" cells.

END CELL REGULATOR SWITCHES.



THE BOOSTER.

The functions and details of the positive and negative cells are identical in all respects, hence the positive set only will be discussed.

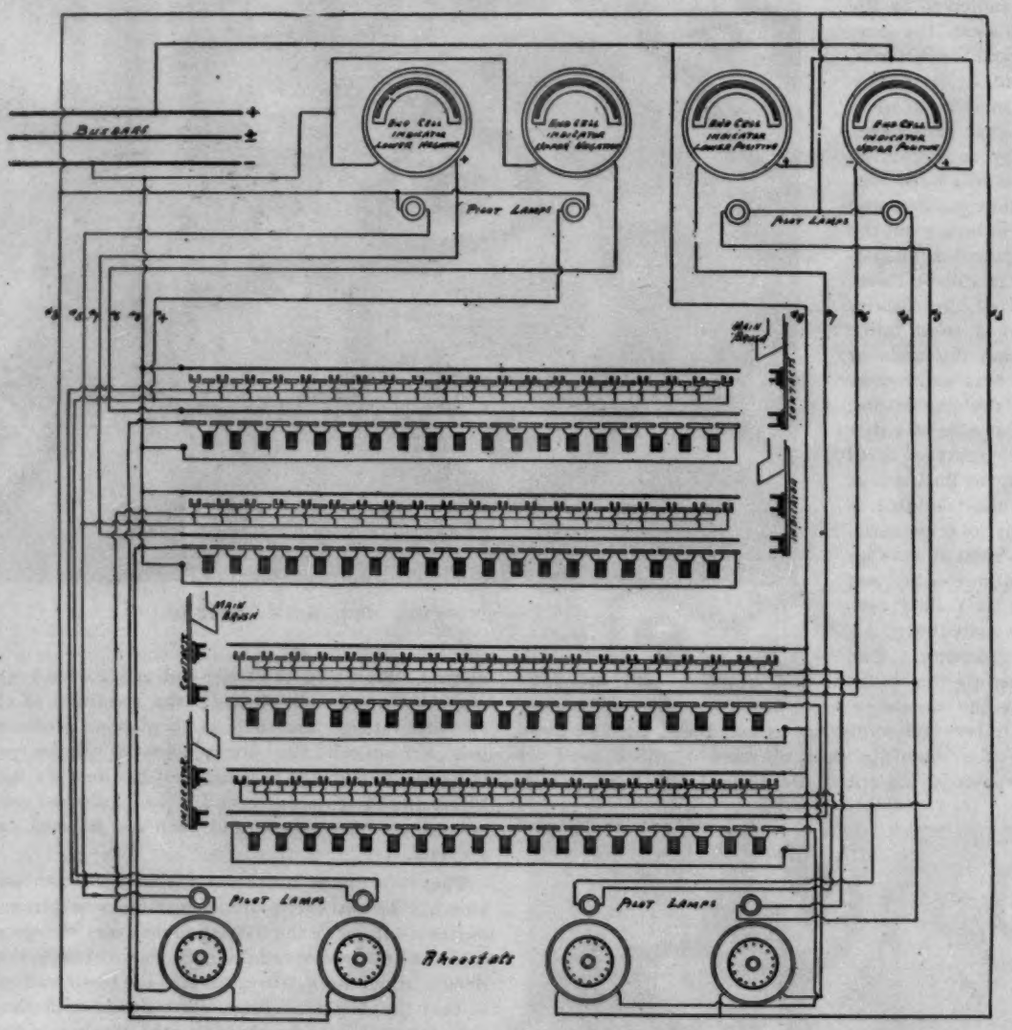
Taking therefore, the upper battery of seventy-five cells, as shown in the upper half of the general circuit outlines on the preceding page, it will be seen that its negative end is connected to the neutral 'bus bar through the single pole single throw neutral 'bus switch *a*, while the storage cells along the positive end of the battery are connected by means of the two end cell switches diagramatically shown. As these switches are entirely independent in action, it is easy to perceive how the upper end cell switch for instance, may be run further along the series of battery, raising the battery potential between the cell switch and neutral 'bus to the same voltage as that between the auxiliary 'bus and the neutral. Similarly, the lower end cell switch may be placed on, say, the sixtieth cell when, (if the condition of charge and the rate of discharge are such as to give an electromotive force of two volts per cell) the battery potential will be 120 volts, and the battery will carry its proportion of the load on the main 'bus bar by closing the switches *a* and *g*. All switches are of the single pole, single throw type, and each has a rated capacity of 1875 amperes.

Thus it is that if the booster is in operation and the two end switches are in the position just described, the closing of the switch *d* will cause the battery to be under charge simultaneously with its discharge on to the main 'bus through the switch *g*. By opening this switch *g*, then moving the lower end cell switch along so that the battery voltage corresponds with the auxiliary 'bus voltage, or is a trifle above it, the closing of the switch *h* will cause the battery to deliver current to the auxiliary 'bus bar while the battery is still under charge. Now open all switches, and upon closing switch *e* the booster will deliver current to the auxiliary 'bus. With *d* open and *a* and *b* or *a* and *h*, or *a*, *b* and *h* closed, the battery will deliver current to the auxiliary 'bus bar; with only *a* and *c*, or *a* and *g*, or *a*, *c* and *g* closed, the battery discharges current to the main 'bus; and with only *a*, *c*, *e*, and *g* closed, the booster delivers current to the auxiliary 'bus and the battery delivers current to the main 'bus, always, of course, with the end cell switches in proper positions.

It is while the switches are in the position last indicated, with the booster either in or out of service, and the end cell switches so that the battery potential is at normal voltage, that the battery does its best work as a potential regulator, and at the station are exhibited two recording voltmeter charts which attest

the high efficiency of accumulators when used for the purposes of perfecting regulation. The first chart was taken on October 27, 1897, when manual regulation was in vogue in the San Francisco Edison station, and the second chart was taken ten days later, just after the batteries were put in service. The later card shows a remarkable improvement in the voltage line. It is interesting to watch the differential ammeters when working under these conditions; the needles hover about zero, first above and then below, giving and taking as high as 150 amperes, more or less, on either side of zero, as the main 'bus bar voltage varies from the normal because of load changes. The battery acts precisely as a carriage spring which softens down the jolts in a road, or as a fly wheel which tends to preserve constant speed because in direct ratio to the applied electromotive force. The world of science has no more striking exemplification of the balancing of forces than the instance here presented.

It must be evident that the successful handling of a large battery installation depends in a great measure upon the celerity and completeness with which pressure readings can be taken, and how this is accomplished will be seen from the diagram on page 30, on which the 'bus bar, booster, end cell, and main switching arrangements are laid out as heretofore described, but circuits for the voltmeter connections are added in detail. The contact points of the voltmeter switches are for the main 'bus, auxiliary 'bus, upper end cell switch, lower end cell switch, and boosted potentials respectively, for, as shown, both the positive and negative sets of



CIRCUITS OF THE END CELL INDICATOR AND REGULATOR TELL-TALE SYSTEMS.

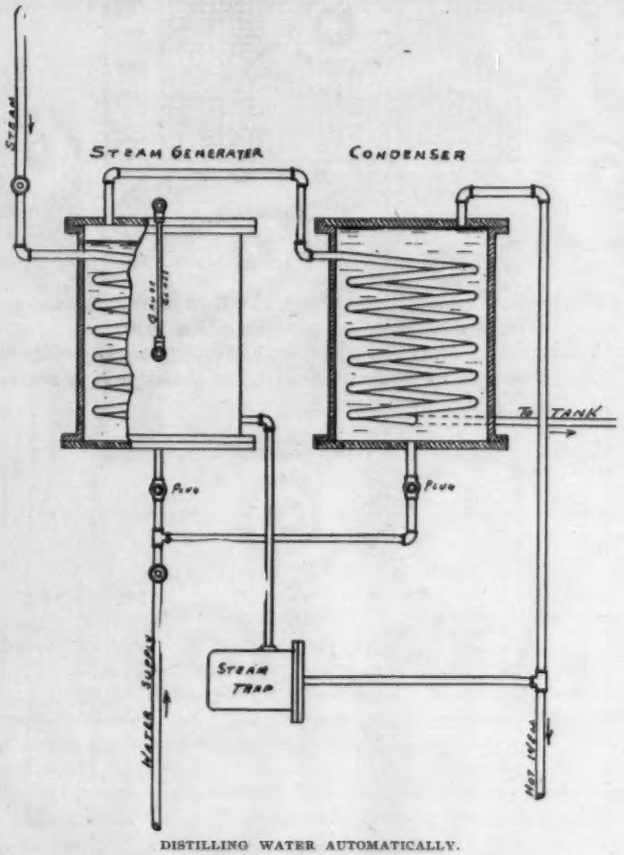
of its momentum, or as an air chamber on a piston pump which at all times mellows the energy of the strokes into evenness of flow.

To check the play of simile that practice may work, it should be explained that the effectiveness of the storage battery as an aid to regulation rests primarily in its extremely low resistance, so that when a large Edison generator is coupled in multiple with a storage battery, each of the same voltage, the potential of one is cushioned against that of the other, and so delicate is the elasticity of the balance that the potential difference of even a few millivolts disturbs the equilibrium, but this disturbance is instantly restored to its former stable condition by the C^2R losses occasioned by the property of the battery in absorbing or delivering current batteries. In addition, end cell pressure switches, (not shown except in the switchboard panel appearing on the following page) are provided for giving the voltage of any end cell individually. The points upon which potential readings are to be had are commutated by means of two five-point voltmeter switches of the ordinary type.

The end cells of the more familiar classes of storage battery installations, such as isolated plants, are controlled direct by an end cell switch placed on the switchboard; that is, from the terminals of each cell a heavy wire is run to its proper contact on the heavy amperage commutating switch on the switchboard, and by means of this switch the end cells are cut in or out direct. The simplicity and efficiency of this method of cell control are evident, and

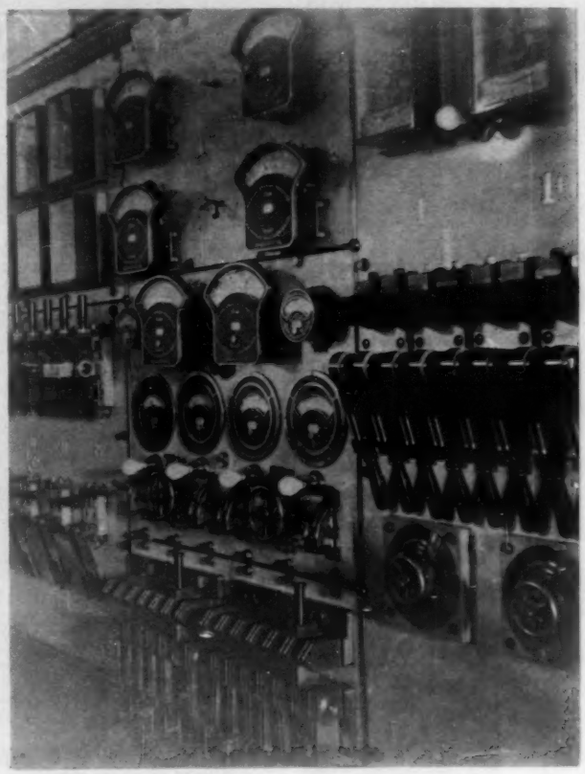
its only disadvantage is that of comparatively heavy investment in copper—only from five to twenty per cent of which is ever in use at any given time—but with storage batteries in central stations of the size of the present installation, the impracticability of placing forty end cell switches, each having a capacity of not less than 2000 amperes, on the main switchboard, as well as the great investment in copper that would be necessary to cable in the end cells to the switchboard individually, render it advisable that they should be commutated at or very near the battery. In the San Francisco Edison station the end cells are placed in a switch room partitioned off at one end of the main battery room and to which the main battery terminals as well as the end cells are carried. These terminals and leads consist of copper bars, the former measuring one inch by three inches in cross section, and the latter measuring one-half inch by three inches, and having therefore an area of approximately 3,820,000 and 1,910,000 circular mils respectively. It is these conductors that are run overhead, as shown in the initial illustration, and which at the point of entering the end cell switch room give the end of the battery room aisle the rather incongruous appearance of being provided with an organ pipe.

Considerable difficulty was experienced in photographing the interior of the switch room, but the view presented on page 27 shows the two sets of regulating switches, one for each side of the three-wire system. The switches, or more properly the sliding brush contacts, are double, one above and one below, and each consist of a bundle of strip copper measuring two inches by three inches over all and bent into U shape, so that one leg of the U bears end down on the contact forming the terminal of an end cell and the other leg bears on a bar extending along the whole sweep of the switch. This bar constitutes the terminal of the 'bus bar,



DISTILLING WATER AUTOMATICALLY.

by means of which the battery current is carried to or from the regulating switch to or from the main switch board for discharging or charging purposes. The switch, which has a sweep measuring 72 inches and is capable of being covered by the mechanism about to be described, in 30 seconds, is rigidly mounted upon an insulated nut traveling upon a screw running axially with the battery terminal contacts and bar, and this screw is operated by a one-half horse-power Lundell motor through worm gearing so arranged that by cutting in an idler gear the motor may be cut out and the two regulating switches of a set may be operated man-



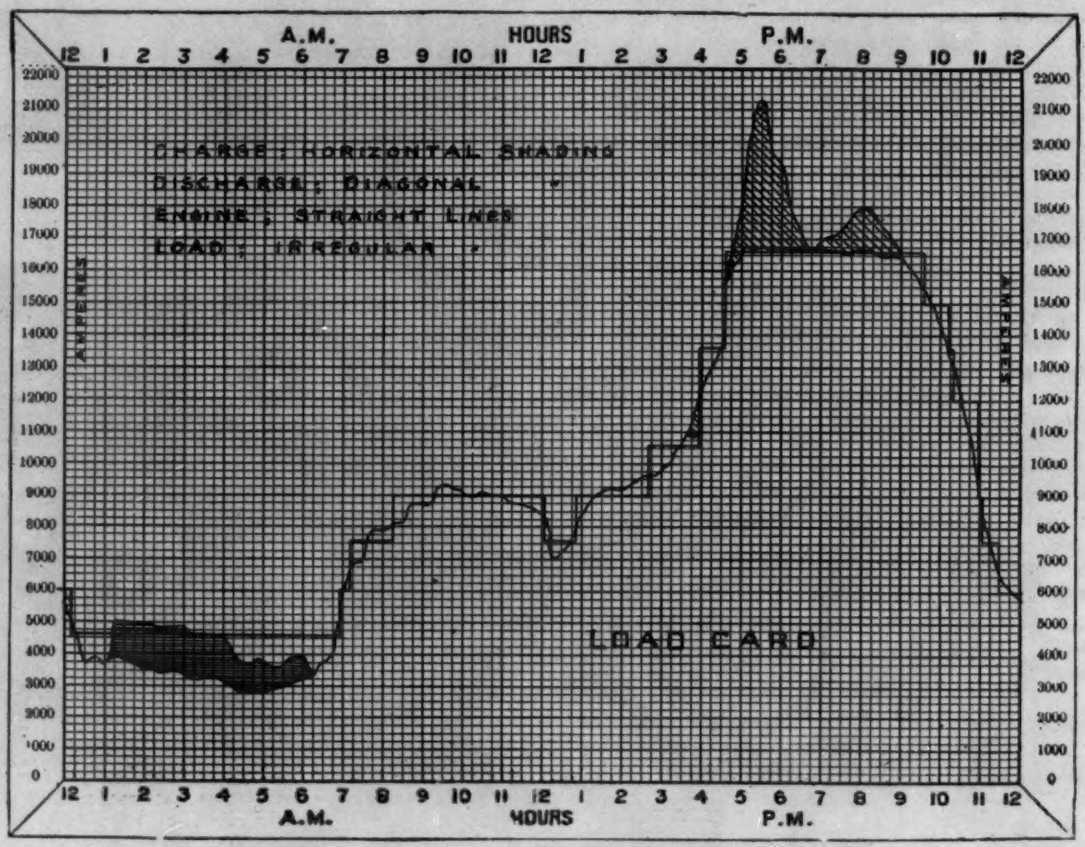
BATTERY PANEL ON THE MAIN SWITCHBOARD.

ually either separately or together through a hand wheel, as is shown in the general circuit diagram. There are four of these end cell regulating switches, two for the positive and two for the negative side of the three-wire system, and each is separately controlled and operated by an independent motor.

As has been intimated, the operation of the motors driving the end cell switches is controlled by the attendant at the main switch board by means of an edgewise lever switch for each of the four end cell regulators, he being guided by a pilot lamp in its manipulation. For simplicity's sake only the motor connections will be considered at present.

In the diagram of connections for the motor contolling switch appearing on page 26, the dynamo represents the source of current, which in the present case is the main 'bus-bar potential of 120 volts. The motor is a simple series machine whose fields, in series with the source of supply, terminate respectively in the sliding contacts *7 C* of the edgewise lever switch represented in the diagram by diagonal shading. These contacts are on the lever and slide along the runways. When the lever is raised the motor runs in a direction causing the end cell brushes (supported on the traveling nut) to cut in more cells; when the lever is lowered, the operation is reversed and the end cells are cut out. On raising the lever the sliding contacts *7 C* come in contact with plates *4* and *6* respectively, which, it will be seen on tracing the connections, merely excites the fields through 150 ohms of resistance. Advancing the switch to plate *5* cuts out eighty ohms of the resistance, while the current is not thrown into the 240-volt armature until the contact *C* is fully on plate *1*, immediately after which the remaiuing seventy ohms of resistance is cut out by the "shorting" of plates *5* and *6* by contact 7, when the motor is at full speed. The process is reversed on restoring the lever to its normal posi-

tion, except in that as the sliding contact *C* bridges plates *1* and *6*, the armature is short circuited while the fields are excited, which causes it to stop instantly. Throwing the lever downward executes the same circuit procedure except in that it reverses the direction of armature rotation. The 240-volt armature is used on

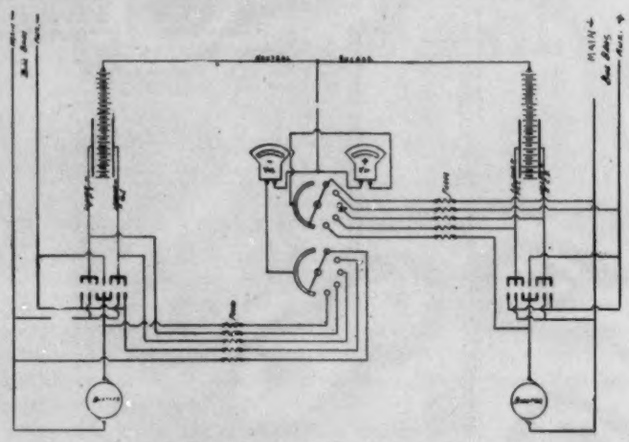


LOAD CARD, DECEMBER 18, 1897.

a 120-volt circuit in order to prevent sparking at the brushes while the armature is under short circuit during the excitation of the fields, as well as to give the preferably lower speed.

The disaster that would result to the storage cell and the controlling switches from the dead short circuiting of the battery, which would cause a "short" of several thousand amperes, makes it necessary to render such an occurrence impossible, and the means by which this is accomplished forms an interesting feature of the installation. Though the commutation of end cells resembles the varying of resistance in a rheostat, the two processes are similar only in appearance. It is almost as essential to good lighting service that there should be no break in the commutation of the end cells, as it is necessary to the operation of a dynamo in service that the resistance in its rheostat should be increased or decreased step by step without breaking the field circuit. In the rheostat, however, the short circuiting of the contact strips forming the resistance terminals is of no consequence, but the short circuiting of the terminals of a ton and a half storage cell means a discharge of considerably more than 10,000 amperes, hence it is not to be permitted under any circumstances. The problem is, then, to commutate the end cells without short circuiting them, so that the battery discharge will not be interrupted. To do this the U-shaped brush as it slides along driven by the traveling nut, must bridge the two plates forming the poles of an end cell—otherwise heavy sparking will occur on breaking the circuit and intolerable jumping of the potential would accompany the cutting in or out of every cell—and short circuiting with its evil consequences is averted by splitting the sliding brush and establishing an electrical connection between the two sections of the brush through a strip of German silver seventeen inches long by one-sixteenth of an inch thick by one inch wide. In service it carries 1750 amperes, hence as the sliding brush switch passes, it throws a partial short circuit of about .001 ohms upon each cell, and in so doing renders commutation of the end cell at once sparkless, uninterruptive, and non-injurious to either cell or switch.

The traveling break switch is not, however, the comparatively simple contrivance thus far indicated, but although it is not especially intricate or complex, it is sufficiently so to be difficult to describe or present diagramatically. The line drawing on page 28, showing the circuit connections for the "tell-tale" indicator and the pilot-lamp system, appearing at the ends of the

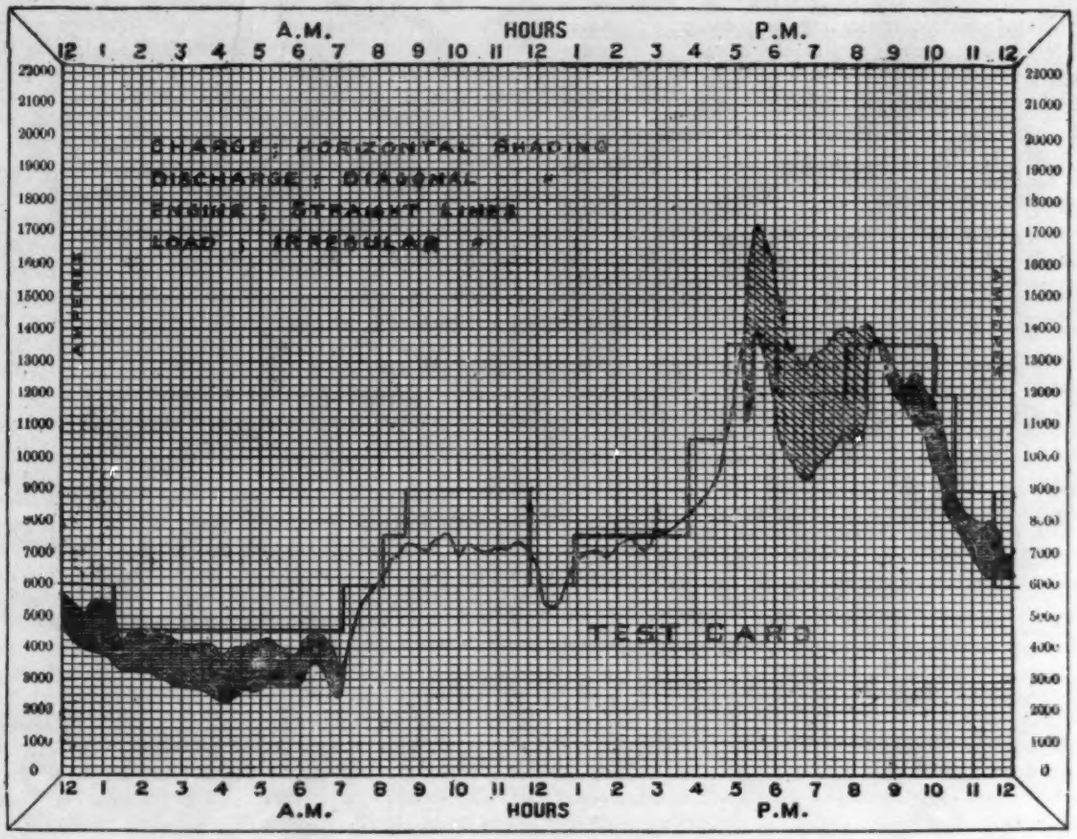


THE MAIN VOLTMETER CONNECTIONS.

four series of the nineteen resistance coils, shows the outline form of a half of one of the two main sliding brushes. The split referred to as being in these brushes, is not central but occupies practically a third of the face of the contact surface, so that as the brush advances to cut in an additional cell, the smaller segment of the brush acts as a trailer. When the main segment is well on the positive contact plate of any cell, the trailer segment is on its negative contact, hence the partial short circuiting of the cell through the seventeen-inch resistance strip; before the main segment is fully on the positive contact, the trailer segment leaves the negative plate and the spark that occurs from the breaking of the 1700-ampere partial short circuit is taken up by a secondary trailer which closely follows the smaller segment of the brush. This secondary trailer is of carbon and bears upon the ends of the cell contacts. The main contact brushes, therefore, run without sparking, and the spark which occurs at the secondary trailer does no injury as it breaks between carbons. Two bars, each supporting two downwardly-projecting, close-circuited points, follow along with the main brushes, but have no connection therewith beyond their tell-tale functions.

When it is remembered that the motor operating the sliding brushes is controlled by the attendant at the main switchboard in another building, and when it is realized that the leaving of the switch in any position other than being squarely on a cell terminal, would cause the rapid discharge of the battery from the partial short circuiting previously described, the necessity for having a device which will at all times indicate the exact position of the sliding switch, will be appreciated. Of course, this might be done by mechanical means or through synchronous motors were it possible to reduce them to absolute synchronism at all speeds or either direction of rotation; but the mode adopted is based on the same principle as is used with tell-tale devices on warships, where indicators placed on the bridge give information at all times concerning, for instance, the position of the rudder, or the speed and direction of rotation of the engines.

How this is accomplished will be understood by reference to the diagram on page 28, on which appears, at the top, the three-wire main 'bus bars, the four end cell indicators, and the four pilot lamps for the indicators, respectively. These devices are on the main switchboard in the Edison station proper, while in the battery room are located the remaining devices appearing on the diagram. The circuits shown are those for handling the thirty-eight end cells of the whole battery, and as each of the two series of end cells has two end cell switches as already described, there is evident necessity for an indicator for each of the four end cell switches. These switches are known as the lower and upper negative and lower and upper positive end cell switches respectively, and each such switch has its own indicator as shown in the diagram. The four pilot lamps appearing in the lower portion of the diagram are used for resistance purposes to cut down the voltage applied to the pilot lamps on the switchboard panel; hence, strictly speaking, they are not pilot lamps at all, but are resistance lamps, and as such are located in the switch room.



TEST CARD, NOVEMBER 5, 1897.

The principle upon which the indicators are operated is simple: nineteen coils of German silver wire looking like the electro-magnets of telegraph sounders, are placed in series across one side of the three-wire system, also in series with a rheostat by means of which the current is adjusted so that there will be a drop of exactly five volts across the terminals of each German silver resistance coil. The indicators are merely Weston circular type voltmeters calibrated to five volt divisions, the divisions being consecutively numbered from 56 to 75 inclusive—which are the numbers of the nineteen end cells. If now the negative terminal of the lower negative end cell indicator be connected to the negative of the three-wire system as shown in the diagram, and the positive terminal of the indicator be connected to a brush

which trails along, completing the circuit through contact plates forming the terminals of the resistance coils, the number of the coil on which the brush is resting will be shown on the indicator, provided the indicator and coils have a common source of current supply. The diagram shows the circuit connection for accomplishing this, but instead of the traveling contact referred to as brushes, the circuit between the coils and indicator is completed through the indicator contacts shown, which are rigidly secured to, though insulated from, the main brushes of the end cell switch. The variable terminal of the indicator consists of a straight brass bar paralleling which, and separated therefrom by about half an inch, are the nineteen contact plates representing the terminals of the resistance coils. The indicator contacts are Ω-shaped bridging contacts which run along this bar and the plates according to the position of the main brush, thereby placing some particular plate in electrical connection with the variable terminal of the indicator.

The indicator, therefore, only shows the number of the end cell that is in actual service, but does not convey to the switchboard operator definite information concerning the position of the main brushes. This is done entirely by means of the pilot lamps through the arrangement of electrical details according to the scheme presented in the upper series of devices shown in the diagram. A long, straight bar constitutes the variable terminal of the pilot lamp, as it was in the previous instance of the indicator, and upon this bears one leg of another Ω-shaped bridging contact, the remaining leg of which closes the circuit alternately through U-shaped or straight bar terminals. When the traveling contact closes the circuit between the U-shaped terminal and the long horizontal bar, full voltage is thrown upon the pilot lamp causing it to burn to full candle power; when the traveling contact short circuits the short plate and the long bar, the pilot lamp in the switch room, as shown at the bottom of the diagram, is cut in in series with the pilot lamp on the main panel, causing the last named lamp to burn at one-half candle power; when the traveling contact rests on the fibre plate between the prongs of the U-shaped terminal, the circuit to the pilot lamp is opened, while at all other positions it is closed—a point which suggests an inaccuracy in the diagram in that the short bar-contacts between the U-shaped contacts should be as broad as the latter are deep.

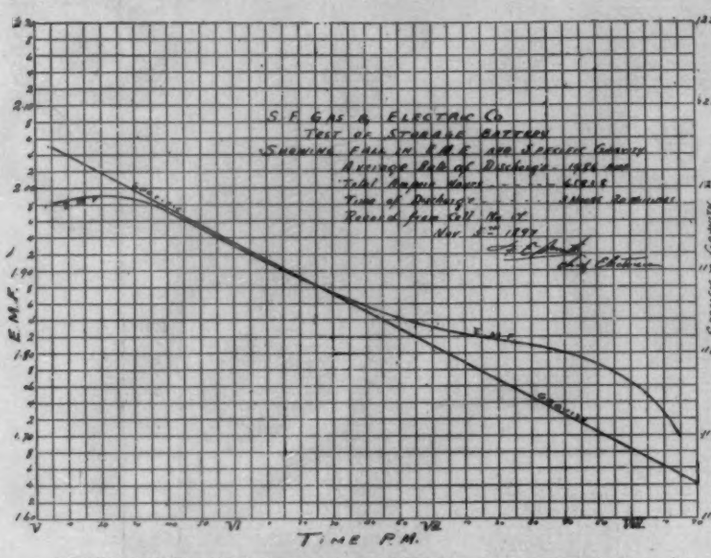
When the pilot lamp is at full candle power, the main brush is squarely on a cell terminal and no current is flowing through the heavy German silver partial short-circuiting resistance, but when the pilot lamp is at half candle power, the sections of the main brush are short circuiting the terminals of a cell, and half candle power in the pilot lamp is, therefore, an indication of the fact that the main brush is in a position which it may occupy only momentarily or while the brush is in transit.

The manipulation of the end cell switch is a process requiring close observation of the pilot lamps and quick handling of the motor controlling switch. Switchboard attendants however, soon become very dexterous in this, and the main end cell switch is handled with the utmost precision, invariably being stopped within one-sixteenth of an inch of being squarely on a cell terminal.

The battery panel pictured on page 29 is inserted in the main Edison switchboard as shown. The panel is in three sections, the upper containing Weston station instruments, but from this two differential ammeters have been taken and mounted on the auxiliary switchboard so as to be more readily observed by the operator. The next panel carries at the top the two main ammeters at the sides of which are small voltmeters having a range of five volts for taking the voltage of individual end cells as described. Below these are the four end cell indicators, underneath which are the edgewise switches controlling the motors, the electrical details of which appear on page 26. The lower panel carries the heavy switches indicated by letters in the diagram showing the general wiring scheme.

The load and test cards shown on pages 30 and 31 respectively, are really self-explanatory, as they present a graphic record of the operation of the station on the days named. The five large engine generators in the station each have a rated capacity of 3000 amperes and the small engine set delivers 1500 amperes; hence, reference to the load card shows that at midnight two large engines were running, but that a few minutes after, one of the large engines was shut down and the small engine started. By one o'clock, a. m., the load had fallen to about 3700 amperes, leaving one of the engines underloaded by approximately 1000 amperes. At 1:15, therefore, the battery was put under charge, which caused the engines to run slightly overloaded until 3:15 o'clock when the load had dropped off so that the engines were running at their rated capacities. This condition prevailed until 4 a. m., when the charging rate was decreased for the purpose of preventing the excessive generation of gases during the conclusion of charging and the loss of energy that such generation of gases represents. From 4 o'clock until about 6:20 a. m., when the battery charge was completed, the engines were running underloaded by a maximum of twenty per cent., when the increase of the load caused the starting up of other engines at the hours indicated by the straight lines. How the engine line follows the load line in central station work is clearly shown in this diagram, from which it will be seen that from 7:15 to 7:30 a. m., from 8:15 to 9:15 a. m., from 11 a. m. to 12 m., and from 12:15 to 12:45 p. m., etc., a margin in engine capacity existed which might have been utilized for charging purposes, and that from 7:40 to 8:15 and from 9:20 to 10 a. m., etc., periods existed when the battery could have carried those portions of the load which were in excess of the generator ratings, but the well known flexibility in the capacity of a generator, coupled with the very slight amount of variation from the load line, made it of no material advantage to cut in the battery, although this was done for twenty minutes or so shortly before 4 o'clock in the afternoon as shown. At 4:40 however, the five large engines and the one small one were all in operation to their rated capacity, to-wit: 16,500 amperes, when the storage battery took up the peak of the load, reaching its maximum discharge of 4500 amperes at 5:30 p. m. It is at this hour in winter when the motor load overlaps the lighting load in San Francisco, while the second peak at 8 p. m. is commonly referred to as the theatre peak. The test card given suggests, among other things, the capability of the battery for enduring hard service.

There are several characteristics of a storage battery installation that are worthy of particular consideration, one of which is the rapidity with which it recuperates its electromotive force and


S. F. Gas & Electric Co.
Test of Storage Battery
Showing Cells in R.R.C. and Specific Gravity
Average Rate of Discharge 1868 Amps
Total Ampere Hours 6728.8
Time of Discharge 3 Hours 36 Minutes
Record from Cell No 17
Nov 5th 1897
E.M.F.
Specific Gravity
Time P.M.

SPECIFIC GRAVITY AND ELECTROMOTIVE FORCE LINES, TEST NOVEMBER 5, 1897.

capacity after a heavy discharge. The voltage of a storage battery is inverse to the discharge rate, and is also dependent to a lesser degree upon the amount of charge remaining in the battery, and this is shown graphically in the electromotive force line appearing on page 32, plotted from five-minute readings taken during the test run of November 5th, 1897. The irregularity of this voltage line is due to several causes, principal among which are the varying rates of discharge. The constant decline of electromotive force as the cell nears exhaustion, is marked, though when the voltage had reached its lowest point during discharge, if the discharge had been stopped, the voltage of the battery on open circuit would have been found to be considerably higher per cell than during discharge.

Evidently then, the electromotive force per cell forms a variable quantity not directly dependent upon either the charge or discharge rates or the quantity of charge in the battery, but fortunately the station attendant has in the hydrometer a perfectly reliable gauge for measuring the quantity of energy in the battery, and this gauge is as accurate as is the lineal one painted up the side of a gas holder. During the test referred to, the hydrometer was read with the voltmeter every five minutes, and from these readings the specific gravity curve was plotted in the absolutely straight line shown. A more reliable electricity gauge is therefore not to be conceived.

There remain but two other devices to be described, viz.: the condenser for supplying distilled water to replenish the loss in the battery electrolyte from evaporation, and the portable hydrogen generator for burning the lead lugs of the cells together. The latter is merely an adaptation of the ordinary form of hydrogen generator familiar in laboratories, but of larger capacity. It is automatic in action in that if more hydrogen is generated than used, the gas forces the sulphuric acid solution down from the cell containing the zinc spelter and up into an upper chamber, thereby stopping its generation. The condenser, shown diagramatically on page 29, is also automatic in action and has a capacity of delivering twenty-five gallons of distilled water per hour. It consists of two cast-iron cylinders of the form shown, resembling an ordinary type of feed water heater in construction. Live steam is introduced into the worm of the first cylinder, the water about which is taken from the city supply and converted into steam whence it is carried in the manner shown to the worm of the condenser in which it is condensed and taken to the distilled water tank. The steam generator is provided with a water glass in order that the water may not be allowed to reach the outlet. Cold water is introduced into the condenser from the same supply pipe, and on setting the stop-cock plugs immediately below tne generator and condenser respectively, as well as the stop-cock in the water supply pipe, the amount of inflow is gauged so that the loss of water from evaporation in the generators is compensated and the water level remains at a standstill. The water still was designed by an employee of the San Francisco Gas and Electric Company.

In conclusion of this description, it may be well to state that Mr. Joseph Wetzlar has recently given an excellent description of a modern process of battery manufacture,* from which it appears that the positive plate of the "Chloride" accumulator, which is used exclusively in the San Francisco Edison station, is of the English type known as the Manchester form. It consists of an active material of peroxide of lead, formed after the Planté method on a rosette or coil of rolled lead tape, corrugated and coiled automatically, and pressed into an antimonious lead frame or grid, which makes a practically non-corrodible, rigid and conductive support. The antimonious lead used in making the positive plates is first fed into melting pots which are fired by oil and hold about four tons each. Hinged cast iron moulds, with steel buttons corresponding to the holes in the grids are used, and the feed is orificed to fit a nipple which is connected to a lead pump delivering the molten lead to the mould so as to cast the grid at a pressure of about one hundred pounds to the square inch. The lead ribbon, which eventually becomes the active material, is received on reels in the form of lead tape, and is fed into a coiling machine that corrugates and cuts it into proper lengths, then coiling it into rosettes of the required size. These rosettes are placed in templates and driven into the grids by hydraulic pressure. The plates are then "formed,"—a process of charging and discharging at various rates uninterruptedly for several days—after which they are sampled for testing in the commercial laboratory before being shipped.

The name of this accumulator is derived from the chloride of lead entering into the pastilles forming the negative plate. These pastilles are keyed together with a frame of antimonious lead forced around them. The chloride used is received at the factory in the form of a white crystalline powder, 100 per cent. pure. It is melted at great heat in reverberatory furnaces holding about one ton each, and then ladeled into casting moulds, making square pastilles of four square sub-divisions, divided by two small grooves on each side, perpendicular to each other. At the intersection of each, in the middle of the pastille, is left a hole, and the pastilles, after being trimmed, are conveyed to the framing moulds. These are similar to the positive moulds, and the pastilles are placed therein by hand, being held in position by countersunk recesses and small pins. When the mould is filled, the molten lead pump is again brought into service, and the result is the framed negative in chloride form. The superfluous lead is then scraped off and it is sent to the reducing room where it is placed between sheets of zinc in an electrolyte chloride of zinc, thereby eliminating the chlorine from the chloride, and reducing the pastille to a very porous, crystalline mass of spongy lead, the crystals of which lie transversely to the plane of the plate and are beautifully pronounced, being plainly seen by the naked eye. After being washed, the plates are placed in tanks as cathodes to the current for several hours to insure the entire elimination of the chlorine, when they are taken out for shipment as finished negatives.

This interesting plant was installed by the Electric Storage Battery Company, of Philadelphia, and this comprehensive description of it was made possible through the valued co-operation of Messrs. C. O. Poole, L. D. Heitzroth, and R. G. Manifold, superintendent, assistant superintendent, and chief draughtsman, respectively, of the San Francisco Gas and Electric Company.

The principal features of the storage battery plant in the San Francisco Edison station are conveniently presented in the following table:

ENGINEERING DATA.

BOOSTER.

Capacity of motor.....100 kw.	Delivered voltage.....50
Capacity of generators..... 50 kw.	Ampere capacity of generator armatures..... 1000
Number of generators..... 2	
Applied voltage.....240	

STORAGE BATTERIES.

Number of sets..... 2	Improves station efficiency. Materially
Number of cells per set..... 75	Improves load factor. About 5 per c'nt.
Number of end cells..... 19	Capacity varies with discharge rate according to the following table:
Plate dimensions.....15½x32 in.	
Containing cell.....39½x46½x18 in.	
Lining of containing cell....4-lb. lead	
Number of positive plates 25	
Number of negative plates..... 26	
Number buttons in positive plate. 531	
Number buttons in negative plate. 512	
Type of positive..... ...Manchester	
Type of negative .....Chloride	
Weight of plates per cell.....2000 lbs.	
Weight of electrolyte per cell..850 lbs.	
Total weight per cell..... 3334 lbs.	
Maximum electromotive force	
..... 150 volts per set	
Ampere efficiency.....85 per cent.	
Watt efficiency.....70 per cent.	
Sp. Gr. when fully charged. ..1.204°B.	
Sp. Gr. when discharged.....1.160°B.	

Disch'rge in Amperes.	Capacity Amp. Hours.	Disch'rge in Amperes.	C'p'city Amp. Hours.
700	7000	2200	4680
800	6825	2300	4550
900	6650	2400	4430
1000	6500	2500	4310
1100	6325	2600	4200
1200	6160	2700	4090
1300	6006	2800	3980
1400	5850	2900	3875
1500	5680	3000	3780
1600	5525	3.00	3700
1700	5370	32 0	3630
1800	5225	3300	3570
1900	508	3400	3530
2 00	495	3500	3500
2100	4800		

"Miners interested in electrical power will find this article well worth preserving," is the comment made by *The Mining and Metallurgical Journal* after reprinting the introduction of the serial now running in these columns on "Electricity in Mining."

* "The Electrical Engineer," (N. Y.) Vol. XXV, No. 521, page 443.

Transmission

POLYPHASE INDUCTION MOTORS.

ALTERNATING current motors, although developed and perfected much later than direct current motors, were soon recognized to possess such great practical advantages that they have by rapid strides largely supplanted the latter in many important applications. They have, in fact, done more; being advantageously used in places where electric power could not be previously employed by reason of some of the inherent characteristics of direct current apparatus.

Alternating current apparatus, owing to the field which it originally occupied, was for a long time looked upon by many as applicable only to the transmission of power over long distances. The extreme simplicity and flexibility of the alternating system, however, added to the attractions of the polyphase motor, have led to the use of polyphase apparatus for the distribution of power in factories, mills, mines, and other industrial establishments where the distances are comparatively short. A large factor in the present popularity of alternating current power is due to the high state of perfection to which the improved polyphase motors have been brought; yet despite their practically exclusive use on all power transmissions, a knowledge of their mode of construction and principles of operation are not commonly understood. To give needed information on these points may best be done by describing distinctive forms of apparatus, for which the type "C" motor of the Tesla polyphase system, as brought out by the Westinghouse Electric and Manufacturing Company, is first selected for illustration and description. Tesla polyphase induction motors have two main elements; viz.: the primary, which is directly magnetized by the currents supplied from the line circuits; and the secondary, in which low potential currents are induced by the action of the primary. The windings of the primary are so arranged that when supplied with alternating currents differing in phase; *i. e.*, polyphase currents, a rotating magnet field is produced. This field acts upon the secondary winding and induces currents therein. Rotation is produced by the action between the secondary currents and the rotating field of the primary. The principle upon which motors of this class operate was discovered by Mr. Nikola Tesla, whence their name.

FIG. 1.—A TESLA INDUCTION MOTOR COMPLETE.

The revolving element of an induction motor may be either the primary or the secondary. In the motors described herein, the primary is stationary and the secondary revolves; hence, for purposes of comparison, the primary may be regarded as corresponding to the field magnets, and the secondary as corresponding to the armature of a direct current motor.

The form of the motor is shown in the accompanying illustrations, among which is that of a complete machine as shown in figure 1. It will be noted from the illustrations, that from a mechanical standpoint the induction motor is reduced to the simplest possible elements; *i. e.*, a stationary part, permanently connected to the main circuits, and a rotating part having no electrical connection with any other portion, and absolutely no electrical contacts or adjustments; in fact, no sliding or working friction except that of the shaft in the journals. It will therefore be observed that as a piece of moving machinery this type of motor is designed and built to operate for long periods of time with but a very small amount of cleaning and an occasional renewal of oil.

The hollow cylindrical frame of cast iron shown in figure 2, in which the primary is mounted, forms a base for the machine and also supports the two brackets carrying the self-oiling bearings. Ordinarily, perforated iron plates fitted into these brackets protect the rotating element and permit excellent ventilation, but they may be replaced by solid plates when it is desired to make the motor absolutely dust-proof. It will be noted that the housing compietely encloses the primary and secondary elements, and protects them from any external damage. The primary element, also shown in figure 2, is built up of laminated sheet iron rings, slotted on the inside to receive the conductors. These rings are rigidly supported by the cast iron housing which encloses the primary. The conductors are machine wound coils, which are thoroughly insulated before being placed on the core. The secondary, which is shown in figure 3, is built up of laminated steel discs, made of a high grade of metal, mounted upon an open spider, and carrying in slots around the periphery the rectangular copper bars of the winding. The construction is such that the conductors cannot be thrown out by centrifugal force, the whole secondary being extremely simple, rigid and durable. Its conductors are all purposely short circuited, therefore it is evident that no accidental short circuit can possibly occur that will cause injury to the windings, and the danger of interruption to service from this cause, always a menace in direct current apparatus, is absolutely eliminated. The construction is also practically indestructible from heating, raising of coils, or mechanical injury in handling. This is undoubtedly the simplest and most durable form of secondary ever devised. Moreover, the end brackets may be bolted to the frame in any one of four different positions, so that the oil chambers in the brackets will be in the proper position whether the frame is bolted to the floor, the wall, the ceiling, or at a forty-five degree angle.

The type "C" motor is made with a variable speed for cranes, elevators, hoists, and similar classes of work, the variable speed motor being especially designed to give a proper speed curve, and is supplied with suitable regulating devices when necessary.

The power factor of an induction motor is found by dividing the real horse-power applied to the motor, by the apparent applied horse-power.

The energy supplied to a direct current motor is found by multiplying the current by the voltage; but in the case of an alternating induction motor, this product, designated the "apparent' energy, is greater than the real energy on account of the fact that

the current in such large motors "lags" behind the electromotive force, and hence the useful effect is less than would be the case if the current and electromotive force were coincident in phase. The current, however, exerts its full heating effect upon the conductors, and the excess current causes a corresponding drop of potential in the circuit. It is therefore desirable to reduce the lag as much as possible; *i. e.*, to bring the real and apparent energies

FIG. 2.—PRIMARY, WITH WINDING COMPLETE.

to coincide as near as we can. If it were possible to entirely eliminate the lag, the real and apparent horse-power would be equal, and the power factor would be 100. Special attention has been given to this matter in the designing of these machines, with the result that their power factors are very high.

The designs and principles governing the construction of the type "C" motor are fortunately favorable to a particularly attractive feature; *i. e.*, the maintaining of a high and almost constant efficiency from full load to one-half load. Under the conditions which prevail in a very large proportion of electric motor service, the motors are operated much of the time at considerably less than their full rated capacities. With the type "C" motor, therefore, by maintaining a constant efficiency, there can be secured to the user an all day or average efficiency very much above that heretofore possible, with either direct or alternating current motors. The variation of speed between no load and full load is small, being less than that found in direct current motor practice.

A polyphase induction motor may be started by connecting it directly to the circuit with an ordinary switch, and small motors are so started in practice. The larger motors, however, are started on a reduced voltage, the full electromotive force of the circuit not being applied until the motors have reached a considerable speed.

In the Westinghouse system, the low electromotive force is ordinarily obtained by the auto-starter, shown on page 37, and which consists of a double throw switch mounted on a cast-iron box in which are two auto-converters. When the switch is closed in the position shown in the cut, the auto-converters are connected across the circuits and deliver a low electromotive force to the motor, but when the switch is thrown in the opposite direction the auto-converters are cut out and the motor is connected directly to the circuit. Three or four wires are connected directly to the auto-starter, and the same number of wires connect the auto-starter to the motor. The auto-converters are arranged with loops so that one of several voltages may be applied for starting, thus adjusting the torque for the work the motor has to do. Thus a motor operating a machine having great inertia may be made to give a correspondingly strong starting torque, or one driving a light device may be adjusted for extremely light starting torque with a corresponding reduction of current.

On two-phase circuits in which there are four wires, different electromotive forces exist between the different pairs of wires, and in some cases this affords a simple way of obtaining a low electromotive force for starting. A simple double throw switch is required, by which the low electromotive force for starting is obtained by one connection, and the full electromotive force for running by throwing the switch to the opposite position.

When it is necessary to install motors in a grain elevator, a woolen mill, a mine, or in any place exposed to inflammable gases or floating particles, or not easily accessible, the starting devices may be located at a convenient point more or less remote from the motor, thus eliminating all danger from fire due to possible sparks.

WIRELESS TELEGRAPHY IN COMMERCIAL SERVICE.

MARCONI'S system of wireless telegraphy was first put to test in actual commercial service during the week ending July 23d last when, according to the London *Electrical Engineer*, the Dublin *Daily Mail* and *Evening Express* concluded a most successful series of experiments consisting in the transmission of descriptions of yacht races sailed under the rules of the Royal Alfred Yacht Club regatta. The wireless messages were sent from distances varying from five to ten miles, and were published in successive editions of the evening paper. Not an interruption occurred; the instruments worked splendidly, and not a single message had to be repeated. Signor Marconi was the sending operator, being located in the cabin of a tug which accompanied the regatta, and the messages were received at the land station in

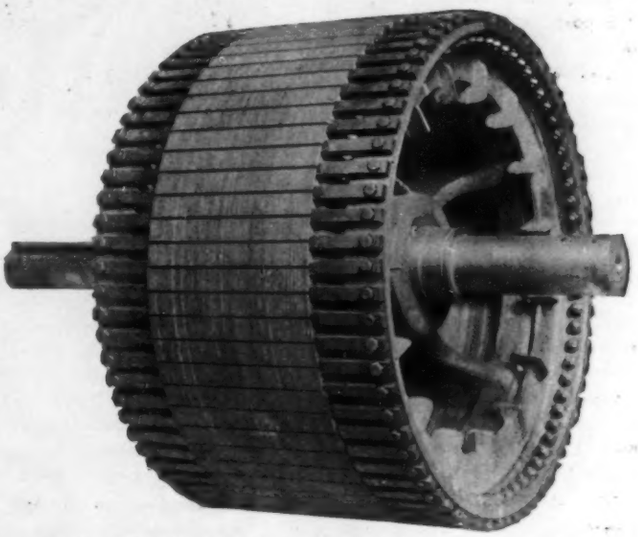
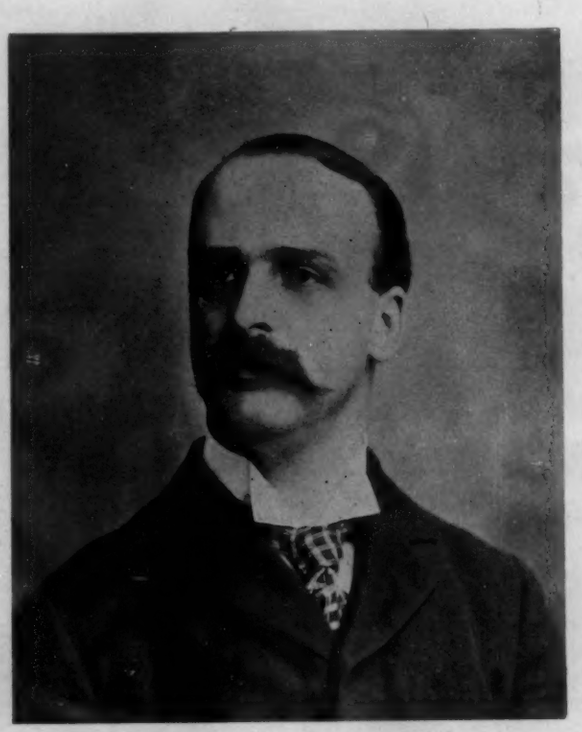


FIG. 3.—SECONDARY COMPLETE, SHOWING COPPER BARS CONNECTED TO END RINGS.

Kingstown, Ireland. A great many representatives of the various telegraph and cable companies were present and followed Signor Marconi's experiment with marked attention and interest.

Personal

MR. R. S. MASSON, electrical engineer for the San Francisco office of the Westinghouse Electric and Manufacturing Company, who has become prominent in the electrical affairs of the Pacific Coast during the past two years, was born on a farm near Hammondsport, N. Y., in, as he facetiously expresses it, "1870, A. D." At school and college he was a close student, graduating with honors from the Lehigh University, at South Bethlehem, Pa., in the class of 1892 with the degree of electrical engineer. Almost immediately thereafter, Mr. Masson started at work with the Field Engineering Company of New York City—a concern which was, at that time, most prominent in the electrical construction and engineering business—being engaged on work for the Buffalo Railway Company, of Buffalo, N. Y. The dissolution of the Field Engineering Company followed not long thereafter, however, but, having proved his value to the Buffalo Railway Company, Mr. Masson's services were retained as general construction engineer until 1894, when, realizing the advantages that would follow from becoming identified with a large electrical manufacturing company, he resigned his position to enter the employ of the Westinghouse Electric and Manufacturing Company at Pittsburg. There he spent about a year in practically all of the different branches of the great establishment, which resulted soon in his being placed in charge of the night force of the testing depaitment. It was in this position that some most valuable experience was gained, so that when the great initial installation of three 5000 horse power generators was installed at Niagara Falls in 1895, Mr. Masson accepted the position of switchboard operator for the Niagara Falls Power Company. After these three mammoth generators had been in successful operation for several months, however, Mr. Masson returned to the employ of the Westinghouse Company at Pittsburg, where he spent another winter in experimental testing in the shops.



RAYMOND STANISLAUS MASSON.

Up to this time the San Francisco office of the Westinghonse company had been practically without the services of an electrical engineer who was thoroughly experienced in polyphase work, and at the request of Mr. W. S. Heger, manager of the San Francisco office, Mr. Masson was chosen as being well qualified for executing the responsibilities of the position. This he has done to the eminent satisfaction of all concerned, and it is not venturesome to predict that he will long continue to be a material factor in the further development of the electrical resources of the West.

MR. WM. S. BRAYTON, of the New York office of the General Electric Company, was married May 3d last, to Miss Alice Wait of Ithaca. Mr. Brayton is a graduate of Cornell and passed through the works at Schenectady before assuming his duties at the New York office. He is a favorite among all his associates, who testified their appreciation by presenting him with a handsome souvenir of their esteem. Congratulations are extended to the happy couple on entering their new career.

LIEUT. W. STUART-SMITH, U. S. N., has been detached from Mare Island Navy Yard and ordered to Seattle, Wash., as inspector of machinery of the United States torpedo boat "Rowan." After the war is over, he will probably return to San Francisco to the practice of his profession of consulting and supervising mechanical and electrical engineer.

MR. C. F. SCOTT, chief electrician of the Westinghouse Electric and Manufacturing Company, and than whom no man has contributed more toward the development and perfection of electric power transmission, is making a tour of the principal places of electrical interest on the Coast.

MR. S. A. DUNCAN, past president of the National Electric Light Association and now special agent of the Postal Telegraph Company, was in San Francisco during the first week of August.

DR. N. S. KEITH has completed the installation of a forty-ton mill at Cyanide, Colo., for the extraction of gold and silver by the Keith electro-cyanide process, and has opened an office at 62 Nevada block, San Francisco, as a mining, metallurgical aud electrical engineer.

MR. T. H. MACDONALD, late chief engineer of the steam equipment of the San Francisco Gas and Electric Company, and more recently of the Hawaiian Commercial Company at Mauii, has been appointed superintendent of the Honolulu Iron Works at Honolulu, H. I.

MR. H. C. WYBRO has turned over the Pacific Coast agency for the Walker Company, of Cleveland, Ohio, to the Wybro-Hendy Company, of San Francisco, and of which Mr. Wybro is president and manager, and Mr. S. J. Hendy secretary and treasurer.

MR. C. E. FREEMAN, of the Department of Electrical Engineering of the Armour Institute of Technology, of Chicago, was a recent visitor to San Francisco, where he stopped for a few days while visiting the points of electrical interest on the Coast.

MR. J. W. BROOKS, late of the Brooks-Follis Electric Corporation, has been appointed western manager of the Fostoria Incandescent Lamp Company and of the Crouse-Tremain Carbon Company, with offices in the Monadnock block, Chicago.

MR. WYNN MEREDITH has resigned from the position of electrical engineer of the firm of Hasson & Hunt, and has joined Mr. A. M. Hunt, late of the same firm, and who is now in Alaska as chief engineer of the Alaska Commercial Company.

DR. F. A. C. PERRINE, electrical engineer of the Standard Electrical Company of California, is now in the East on business connected with the proposed Blue Lakes-San Francisco transmission. He is expected to return in September.

MR. ALEXANDER G. MCADIE, late local forecast official of the San Francisco station of the United States Weather Bureau, has

been advanced to the New Orleans station of the Weather Bureau, whither he has gone to assume charge.

MR. W. A. BURKHOLDER has completed the installation of the telpherage electric freight tramway over the Chilkoot pass, for the Dyea and Klondike Transportation Company, and has returned to San Francisco.

MR. C. R. LLOYD has retired from the Pacific Coast agency of the Fort Wayne Electric Corporation, which is now held by Mr. F. N. Delanoy, with Mr. W. W. Briggs as electrical engineer.

MR. ALLAN H. BABCOCK has become identified with the Standard Electric Company of California in the capacity of electrical assistant to Dr. F. A. C. Perrine, its engineer-in-chief.

MR. M. L. OSLER, the well known salesman of the Washburn & Moen Manufacturing Company, has been placed in charge of the Los Angeles office of that prominent concern.

MR. E. L. BRAYTON, secretary and treasurer of the Pelton Water Wheel Company, is on a business trip to the New York and London offices of the Pelton company.

STARTING NON-SYNCHRONOUS MOTORS.

WITH a suitable resistance in the armature circuit, a single-phase motor can be started by giving a very small initial velocity to the armature, such in fact as can be given by a pull on the belt by hand, says Sig. R. Arno in an Italian electrical contemporary. Once started, the resistance can be gradually cut out. This method of starting does away with the necessity of two windings on the inductor and means for producing a difference of phase between the two.

The author, in his second paper, describes a method of giving the initial starting-pull to the motor by electrical means only. The method is to produce a dissymmetry in the armature at the moment of starting by opening the circuit of one of its windings. Then, provided the armature is not at a dead-point, it will rotate through a portion of a turn, and, if the circuit be then closed, this rotation provides a sufficient impulse to enable the motor to get up speed. Supposing the armature to have a three-phase winding, a three-arm resistance-switch is inserted in the three circuits, the full resistance being the best starting resistance mentioned above. Two circuits are closed through the resistances; the third is brought to one pole of a two pole switch, the other pole of which is in the field circuit. The switch is so arranged as to first close only the field circuit, thus giving an initial rotation to the armature; a further movement of the switch closes the armature circuit and enables the motor to get up speed. The best conditions for starting are obtained by cutting all outside resistance out of the armature circuit, putting it in immediately the circuits are closed. The armature can be moved from a position of dead-point by means of a switch in one of the other circuits; if the double-pole switch be closed, leaving this switch open, the armature will rotate to a dead-point corresponding to this position of dissymmetry. On breaking the circuit and closing the single-pole switch, the position of dissymmetry is changed, and the motor is no longer at a dead-point. The direction in which the motor starts is determined by the circuit in which the single-pole switch is placed.

ACCUMULATOR VARIATIONS AND ACID STRENGTH.

LIEBENOW'S theory, which regards the accumulator as a reversible cell, is contended by F. Dolezalek, in a German electrical contemporary, to be the only one which can be consistently maintained, and with which the behavior of the cell is in agreement. The differences in the electromotive force of accumulators with different concentrations of acid are shown to be in excellent accordance with the values calculated by two independent methods based upon thermodynamical considerations. The efficiency of the accumulator amounts on the average to seventy-five to eighty-five per cent., although ninety-four to ninety-seven per cent. of the current used in charging is recovered on discharging. This is caused by the difference in electromotive force during charging and discharging, which has led to the belief that the action is only partially reversible. This difference is attributed to mechanical hindrances to the equalization of acid concentration in the neighborhood of the electrodes, whereby the accumulator behaves during charging as if filled with a stronger acid, and during discharge as if filled with a weaker acid, than is really the case. It is calculated that the accumulator should work with maximum efficiency when filled with acid of maximum conductivity (30.4 per cent. H_2SO_4). Here also, experiment is in close agreement with theory.

LIGHTER THAN HYDROGEN.

Prof. Nasini, of Padua, has communicated to the French Academy the result of his investigations with Signori Anderlini and Salvadori, into the gases issuing from the earth in volcanic districts, among which they find coronium, hitherto known hypothetically only as a constituent of the sun. The discovery, which in conformity of the results of spectroscopic examinations of the sun, adds another element, and one which seems to be far ligher than hydrogen.

ARC LAMPS AS TELEPHONES.

The flame of an arc lamp is very sensitive to slight variations of the current, such as those produced by induction from a neighboring intermittent current. When the neighboring circuit contains a microphone, the arc may be made to reproduce various sounds and noises communicated to the latter. It reproduces them with great fidelity. Conversely, a sound impinging upon the arc produces in it changes of density, which give rise to changes of resistance and modifications of the current, which may in turn excite a telephone. The arc thus plays the part of a telephone receiver and transmitter.—*Science Abstracts.*

FIG. 4.—AN AUTO-STARTING DEVICE.

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EDITORIAL.

"INSULATORS," AS VIEWED BY A CONTEMPORARY.

Much surprise, not alloyed with approval, will be expressed by electric transmission interests upon reading the leading editorial in *Electricity*, (N. Y.) for July 27th, which contains references to glass insulators for use on high tension transmission lines, the opinions given being far from substantiated by actual practice. Referring to "high tension transmission, or where a line transmits current at a pressure of from ten thousand to twenty thousand volts," our contemporary says:

> Glass or porcelain has to be relied upon almost entirely, although in some cases pottery or stoneware insulators have been used in foreign countries. None of these substances are by any means ideal, and especially glass, which is too brittle and very apt to be broken under a jerk or strain.

Then, further on, appears the equally groundless statement:

> Owing to the brittleness of glass, so far on most of the very high tension transmission lines in this country, porcelain is used.

The forty thousand-volt transmission between Provo and Mercur, in Utah, and which is the highest potential used for transmission purposes in the world, uses glass exclusively on its thirty-two-mile line; the San Joaquin Electric Company, whose thirty-five-mile line was originally equipped with porcelain, has built its thirty-three-mile extension to Hanford with glass insulators and has announced its intention to substitute glass for porcelain insulators on the line between the power house and Fresno as soon as the line potential is raised from ten thousand to nineteen thousand volts for the operation of the Hanford extension. The Yuba-Marysville transmission uses glass exclusively on its 16,500-volt transmission; and, in brief, of all the high tension electric power transmissions on the Pacific Coast, operating or projected, the only noteworthy exception to the broad statement that glass insulators are used wholly or in part—the latter being for new extensions or renewing porcelain insulators that have broken down—is in the 33,000-volt transmission line of the Southern California Power Company, now under construction. Concerning the adoption of porcelain insulators on this line, Mr. O. H. Ensign, electrical engineer for the Southern California Power Company, remarked before the recent meeting of the Pacific Coast Electric Transmission Association, that at the time the Southern California Power Company was trying to decide on the type of insulator it would use, he could not, to use his own words, find a glass insulator "that was large enough to stand the potential without the distance from the tie wire to the pin being too near the sparking distance of the potential used, so we were rather forced to the porcelain insulator." That the trouble Mr. Ensign referred to is now overcome is evidenced in the use of glass in the Provo-Mercur transmission, which has been running since early in March last without trouble. Without doubt, the days of porcelain insulators for use on extremely high voltage lines, are numbered.

While, so far as we know, it is yet to be demonstrated that static electricity exerts any appreciable influence on the temperature of transmission insulators toward the dissipation of moisture that may accumulate thereon, it is well understood that the presence of high tension current on the line tends to preserve its insulation resistance. Witness, for instance, the difficulty that attends the starting of the Provo-Mercur transmission during a rainstorm, (which occasions repeated blow-outs of the fuses before the line can be held) while if the line is already in operation, no rainstorm, however severe, affects it in any appreciable way. Nevertheless, our contemporary's utterances on this point are interesting and are here reprinted:

> On all telegraph lines where glass or porcelain insulators are used there is, as is well known, always more or less leakage due to the insulator becoming damp through the condensation of the moisture of the air. In the case of a high potential transmission line, however, this accumulation of dampness on an insulator does not, as would naturally be inferred, cause a leakage providing the insulator is properly shaped. This is due to the fact that as soon as an insulator on such a line becomes moist and leakage tends to begin, static electricity is immediately formed, which heats the surface of the insulator and preserves comparatively large dry areas between the streams that run down from the falling drops.
>
> This remarkable action of the drying of porcelain insulators by static electricity is probably one of the most valuable discoveries so far noted in the transmission of high potential currents.

SISTER INDUSTRIES, YET ESTRANGED.

No one knows whether the dreamed of Utopia, wherein gas and electric industries will so far overcome their cat-and-dog propensities as to make common cause for the advancement of the industry of artificial illumination will ever be realized, for at times it seems as if those who have hoped for the consummation of this desirable conciliation are at least over sanguine. It must be confessed that the haughty *one* extends but little encouragement to the aspiring *other*, and it is ultra-conservatism thrice personified which accepts evidences of friendship and good will—further, if you please, the substantial testimonials of ripened cordiality—with lukewarmness, or even condescention. Gas and electricity, like pneumatics and electrics,

are sister sciences, and protracted strife between them is unnatural and unwarranted. Together they form the two factors constituting the magnificent industry of artificial illumination; apart, the industry is divided against itself and will never attain the pinnacle of perfection, which, combined, may be easily scaled. United they present a solid front, impregnable alike to internal dissensions or foreign assaults; divided they are ever torn with civil strife and the fullest measure of prosperity is impossible.

Competition to the death, as is being waged in many localities between gas and electric industries, is a senseless and obstinate struggle which throws the greatest possible blight upon any investment, however promising it may appear.

THE INFLUENCING OF STOCK VALUES.

The many depreciations that have been brought about in the market value of illuminating stocks at different periods the country over by reason of announcements of so-called "revolutionizing inventions," bears witness to the fact that as a rule, the opinions which influence stock holders and the financial public in general, are in the main, of a very superficial nature. Too often, indeed, are mere newspaper publications concerning technical matters accepted as gospel truth, even when in bald contradiction to exact scientific knowledge—and stocks slump at their echo as the colt shies at the passing litter. Nevertheless, he is wise who recognizes the menace to which the value of all corporate shares are exposed from changes which may be wrought by the inventor's magic, and he is a veritable dotard who locks himself secure in the belief that the science of electric lighting is preserved wtth immunity from assault along this cause, by reason of its present prosperity. When the truth, ofttimes stranger than fiction, is realized that the efficiency of the incandescent lamp as a medium of rendering illumination from the energy of the coal pile or the water power, is so ridiculously low that the electrical scientist blushes to name it, it is folly to contend that further advance along the line of its development is impossible, or that invention will ever cease its endeavors to improve the present condition.

While the utmost caution must be exercised at all times in taking up the consideration of new inventions, a manifestation of wisdom is shown in giving due attention to each which follows the trend of original research. The latest announcement on the part of the lay press that comes under this category is the publication in a recent issue of the *New York Times* of an article attributed to Dr. Johannes Horowitz, of Vienna, in discussing a new type of incandescent electric lamp invented by Prof. Walter Nernst, and the patent rights for which, it is averred, have been sold to a Berlin syndicate for $1,500,000. Dr. Horowitz states that despite this sale, no practical or commercial use can be made of the discovery—but the why-not is not given.

From the description, it appears that in the Nernst lamp, the carbon filament is entirely done away with, a filament of magnesia or other metallic oxide that has been subjected to an intense heat, being substituted therefor. But to quote Dr. Horrowitz' own words:

> When in a conductive state such bodies allow the current to pass, and through it they are made to glow intensely by reason of the great light-emissive power possessed by the substances. Nernst's incandescent bodies have proved perfectly stable at the enormous temperature (more than 300 degrees centigrade) which is produced by electricity when these bodies are made to glow, a temperature at which platinum wire and carbon filaments become volatile and waste away. This renders it possible to produce a high degree of light intensity by means of a comparatively weak electric current, and the experiments already made have proved that we can reckon on an economy far surpassing that of the carbon filaments hitherto used. Unlike the ordinary incandescent lamp, the Nernst lamp will not require a vacuum, but will shine in the free air; indeed, the admission of air has proved to be advantageous, probably because the chemical changes brought about by the enormous heat, and especially the reduction of the incandescent substance, is compensated when oxygen is taken from the air as a substitute.

Passing Comment

An Editorial Review of Current Events and Comtemporary Publications.

PICTURE TRANSMISSION BY WIRE.

Szczepanik, a young Polish school teacher, claims to have invented a telelectroscope, an apparatus for the transmission of scenes and pictures over a wire, and the details of his invention, minus some of its vital features, appear in *The Electrical Engineer* (N. Y.) for July 7th. It is a combination of lenses, reflectors, and presumably small selenium cells in constant rotation, each reflector being in a state of rapid vibration. The motions of the reflectors of the transmitting and receiving systems are, moreover, synchronical. It is said that according to the testimony of eye-witnesses, the transmission of pictures is perfect, and that the central committee of the Paris Exposition of 1900, where the invention will be shown to the public for the first time, has guaranteed the young inventor 3,000,000 francs. A telephone is usually connected with the telelectroscope to make conversation possible simultaneously with sight.

The perfection and adoption of the telelectroscope plays into the hands of the telephone companies admirably, but the arrival of the time when every telephone subscriber can pay four dollars per month (invariably in advance according to the terms of his contract) for the privilege of having a telelectroscope attached to his 'phone, will not, in all probability, be an unmixed blessing. True, he can call up his friend Jimson and each can read the other's morning paper, (unless they happen to be on a party line and subject to a time limit) but this will be of no especial advantage when newspaper subscriptions are so cheap. Territorial tolls are high, too, which prohibits the interchange of morning paper courtesies between Tompkins, of Petaluma, and Snodgrass, his friend, in Milpitas. But to look at the brighter side: The telephone company could develop a source of princely revenue by arranging the telelectroscope so that on placing the coveted nickel (or mayhap quarter) in the slot and pushing the button "way down," the features and curl papers of the sweet-voiced telephone girl could be made to appear in all their embarrassed glory upon the diaphragm of the contrivance. Then the family physician—what a boon! Imagine him ordering you to step to the telelectroscope and "show me the whites of your eyes," or the inevitable: "stick out your tongue."

All that glitters is not gold, saith the proverb, and the

shimmer of the telelectroscope will be unalluring to many, who will regard its adoption askance, for even in the inventor's Polish name, one sees a premonition of breakers ahead.

"SCIENCE ABSTRACTS."

Of all attempts that have been made to index technical literature, none appears to have been more successful or satisfactory than that of the Institution of Electrical Engineers, and the Physical Society, both of London, as together presented in *Science Abstracts*, a handy monthly magazine which is a trifle larger in size than *Electrical Engineering* of Chicago.

Science Abstracts is ideal in every respect, or at least it will be so if the same care is given to the arrangement of the index for the completed annual volume as has been bestowed upon the monthly issues thus far published. Dealing only with physics and electrical engineering, it is not burdened with a multitude of abstracts along lines wherein the electrician is but little, if at all, interested. Physics and electrics are so closely related as to be often all but indistinguishable, yet in *Science Abstracts* the arrangements are such that the subjects are clearly separated, although jointly presented. Moreover, the abstracts are full, clear, and comprehensive, as though every word was individually weighed; they are not "boiled down" to disjointed skeletons, nor do they contain aught beyond the very gists of the articles. Each abstractor, of whom there are more than fifty, signs his writings with his initials, thus identifying the editorial labors and fixing the responsibility for such. It is both tedious and laborious to search through abstracts made weekly when in quest of the substance of a particular article, and those which appear monthly are far more serviceable in this respect. But where each monthly abstract is conscientiously indexed and arranged to be available for binding into yearly volumes so as to still preserve intact its features of ready reference, it becomes of the utmost value. It is this that *Science Abstracts* accomplishes more effectually than any other similar work yet attempted.

Mining

ELECTRICITY IN MINING.—IV.

AN electric tunnel excavating machine is described in "Engineering" (London), April 22, 1898, page 486. This apparatus removes the earth and the rock, and deposits it upon the attached car. In operation the machine is traveled up to the face and excavates all that can be reached for a distance of eighteen inches to two feet in front of the shield, the portion which the machine cannot reach being the top and the sides. The machine is then run back ten or twelve feet clear of the face and the shield pumped forward, the cutting edge bringing down the remaining portion of the earth. No difficulty has ever been met with in cutting this part of the face, and of course, there is a material engineering advantage in getting a clean cut and insuring that no cavities are left outside the shield. The face being now clear the iron lining is erected and bolted up, and the excavator brought forward for a fresh cut. The usual small boulders are taken out by the machine without difficulty. When large boulders are reached, the earth is cleared out all round by the machine, and the boulder removed by hand.

A fuse is inserted in the lead to the motor so that in the event of too heavy a feed being given no damage will result to the gear. So far no breakdowns have taken place with the exception of the breakage of some buckets, and the excavator has given great satisfaction at work. Being an experiment it was not built so large or heavy as could be employed, and a greater saving would result by the use of a larger machine. As it is, the saving over hand labor is very considerable; the average advance is three twenty-inch rings per shift of ten hours, the number of men at the face, including the engineer, being eight.

The above apparatus, though originally designed for street undesground excavation, is applicable to mining in soft seams, and requires no special intricacies of design, being in effect an electric shovel.

In the operation of drilling, compressed air, steam, water and electricity have each had their day and place, but the electric system is destined to become popular. By its use, holes difficult or impossible of being otherwise reached, except by hand labor, are drilled with ease and rapidity. The motor may be mounted on an iron truck, with the necessary starting resistance, speed reducing gear and switch. The machines are usually shunt-wound, over-compounded, and about two horse-power in capacity. The supply voltage is about 100, and the current four to five amperes The coupling between the motor and the drill may be either an ordinary flexible shaft, or a telescopic shaft furnished with universal couplings. The ratio of reduction of speed may be readily altered by the substitution of a different set of gear wheels at the motor. Thus, by the provision of change wheels, is obtained a large range in the size of the holes which the machine can drill. The motor is supported on trunnions giving a universal motion.

The performance of these machines is most satisfactory. By their use one man and a boy have drilled ⅝-inch tapping holes 1¼ inches deep in tough cast steel at the average rate of more than 100 per day of eight hours; these figures taken from the weekly record sheet, including all setting up, grinding tools, etc.

HISTORICAL.

The superceding of the old pick and shovel methods in coal mining marked the beginning of the application of electric power to mining operations. It was in the coal fields of western Pennsylvania that electrical apparatus was introduced in mines, and the rapid progress made since that time has extended its application into the fields of placer, crusher, and all systems of dealing with the ores of the precious metals, as well as in electrolytic work and refining, and in the modern cyanide process.

An early example of a mining machine operated by an electric motor was in the first pool in the Monongahela coal fields, in 1889. The machine was connected to a Tesla motor, and ran so successfully that a similar installation was made in the following year. In 1890 the Armstrong mine was equipped. The experience gained even in these early installations, proved that electricity was, of all motive powers, the best adapted to such service.

The next class of work to receive the benefit of electrical operation was that of iron mining. In 1890 the Ashland mine of Ironwood, Mich., was supplied with a complete electric lighting plant of 600 lights capacity. This mine is 720 feet deep, and consists of eight layers, connected by ladders, some of which are nearly 100 feet in length. Fully 2000 miners were employed at the time the mine was equipped, and the extent of the system was only equalled by the engineering difficulties encountered in designing a lighting plant for the service. Dampness prevailed everywhere, and to secure perfect insulation every coil of wire was drawn through insulating paint. Four months were required to complete the undertaking, and when complete not the least trouble was experienced in the operation of the system. The generator station was located in the pump house, and the switchboard was constructed of such unique material as beaten boards of white and brown birchwood. In its time, this was considered an important installation and attracted much attention.

Another example of mine lighting, installed in the same year, was that of the Monongahela Mining company. This was a coal mine, and the possibility of using electrical ap-

paratus in the presence of explosive gases was here demonstrated by the Westinghouse experts. The mine circuits were of 300 volts, and 100-volt lamps were used, three being connected in series across the mains.

The Shawmut coal mines, in the state of New York, were among those first to use motors for operating coal cutting machinery. Their first installation consisted of a thirty horse-power Westinghouse generator, and seven alternating current motors connected to mining machines.

With the remarkable advancements made in the transmission of power by polyphase systems, the mining industries of the West were deeply concerned. The first practical illustration of the possibilities in this direction was made by the Westinghouse company in the world famed Telluride mines, which, though hitherto unprofitable, were economically worked by the cheap power supplied through electrical transmission. Fuel, expensive and often unattainable at any price in the elevated mining camps of the Rockies, was done away with entirely, and the power of a neighboring waterfall was made the invaluable adjunct of a quartz crushing plant. Up to 1892, the longest distance of power transmission was three and one-half miles. In that year, a transmission of eight miles was proposed with some hesitancy, but it remained for the Westinghouse company to demonstrate by a successful example the possibility of transmission for fifteen miles. It was near Denver, that a turbine wheel was connected to a Westinghouse generator at the side of a permanent waterfall, and the current transmitted across the mountain to a motor at the mine, with a small percentage of loss and no difficulties in insulation.

The San Miguel Consolidated Gold Mining Company was the company in whose behalf the Telluride plant was installed. The altitude of the mines was 13,000 feet above sea level, and the cost of coal and power up to the time of the Telluride installation, made economical operation impossible. The Westinghouse polyphase system was adopted, and a 100 horse-power generator connected to a Pelton wheel was placed at a distance of three miles from the Gold King mine. A few weeks demonstrated the perfection of the system, and it was extended to all the mines of the company, two 800 horse-power generators being placed at the power plant, and motors and transformers being connected at suitable locations for the work of the various mines.

In June, 1896, one of the largest shipments of electrical apparatus ever made was sent from Pittsburgh to the Boston and Montana Consolidated Copper and Silver Mining Company, at Great Falls, Montana. The latter firm is one of the largest in the mining world, and ordered a complete electrical equipment. The work of the company was largely in the refining of copper and silver. This had been done in the past at large plants in the East, the cost of power in the mining districts being prohibitive. The Anaconda Mining Company had just demonstrated the utility of electric power in a similar class of work, and the former firm decided to follow its example. The turbines were located at Great Falls, Montana, and Westinghouse generators were direct-connected to them. The latter were the largest electrolytic generators that had been constructed up to that time. They were of 1200 kilowatts capacity, producing 5500 amperes at 220 volts. The entire auxiliary apparatus was ordered with the generators, and some idea of the amount of apparatus supplied may be obtained from the fact that eight freight cars were required to transport it from Pittsburg, and that the freight charges alone amounted to $8000.

The most striking step that has been made in advance in recent years, rests, as has been stated, in the introduction and perfection of electric mine locomotives. The Westinghouse and Baldwin companies, working in conjunction, have placed these in several of the important mines of the country, and they have never failed to give thorough satisfaction in combining simplicity and convenience of operation with low cost for the locomotive itself and for the power used. Among the coal mines recently supplied with such apparatus are the Shawmut, St. Mary's, Penna., the Stevens, Acme, W. Va., and the Crozer, Elkhorn, W. Va.

Where some other form of motive power, as compressed air, is already in use, electrical apparatus has often been found the most economical for the prime mover. In the Jumper mine, Tuolumne county, Cal., a combined compressor and electric plant is in operation. A Westinghouse generator, driven by a 250 horse-power Pelton wheel, furnishes the current.

The late exploitation of the cyanide process has given rise to a multitude of new phases of application of electric motors. The largest cyanide mill in the world, that of the Golden Gate, at Mercur, Utah, as described in the June number of THE JOURNAL OF ELECTRICITY, is operated entirely by electric power, the transmission being from Provo, Utah, a distance of thirty-five miles, at a potential of 40,000 volts. The capacity of the mill is over 500 tons of ore per day, with apparatus which could be easily made to more than double that capacity. Transmission is three phase; distribution, at 220 volts, is two phase, and the motors are all of the induction class, aggregating 700 horse-power. The mill company buys the power from the proprietors of the generating station at $60 per horse-power per year, with a minimum consumption of 300 horse-power. At the time the Golden Gate mill was erected, some doubt was felt by the owners as to whether electrical machinery would be found adequate for the heavy work of the plant. It has turned out, however, that the electrical apparatus is the most satisfactory and reliable part of the entire equipment. If a crusher becomes clogged, it is usually the case that a belt or gear will break rather than the motor become stalled. Electric power in mining has come to be recognized as the direction of progress in mining engineering. The example of the Mercur plant is only one of many in which the introduction of electrical apparatus has greatly cheapened the cost of power.

ELECTROLYSIS IN COPPER REFINING.

ELECTROLYTIC processes for the production of refined copper have been developed very rapidly during the past three years, and at the present time, a very large proportion of all the refined copper is thus produced. The Westinghouse Electric and Manufacturing Company have installed a very large amount of apparatus for this class of service. One of the principal installations is at the refinery of the Anaconda Copper Company, Anaconda, Montana, where ten generators of 270 to 300 kilowatts capacity have been installed. Another very large installation is that of the Boston and Montana Consolidated Copper and Silver Mining Company, Great Falls, Montana, where two 810 kilowatt Westinghouse engine type generators are in service.

The latest comer in this field is the Raritan Copper Works of Perth Amboy, New Jersey, which is about to erect the largest copper refinery in the East, having contracted with the Westinghouse Electric and Manufacturing Company for three 600 kilowatt, 150-volt, engine type generators, 150 revolutions per minute, with a nine-section switchboard for electrolytic service, and the operation of two 75 kilowatt, 220-volt, engine type generators, which will be used for lighting and power service. The installation will be the most complete of its kind in the world.

RUBBER WILL NOT HOLD ACETYLENE.

According to a German photographic contemporary, a rubber bag will not hold acetylene gas. In half an hour there is a strong smell of escaping acetylene, and in three days the bag is empty. Thereafter the same bag is found to be perfectly impervious to air, so that the leakage of the acetylene is not due to holes, but depends on the nature of the material of which the bag is made.

Proceedings of the Second Annual Convention of the Pacific Coast Electric Transmission Association, Held at San Francisco, June 21, 1898.---Concluded.

(Continuation from page 17, of last issue.)

MR. ENSIGN: The Redlands generators operate at 2,500 volts, supplying Redlands and the Union Ice Company direct. At this time of year, when the Ice Company's load is the highest, the Redlands load will run up to 30 or 32 amperes per leg, and the ice plant, with both pumps running, will average 45 amperes per leg. The ammonia compressor is a double-cylinder pump, 16x30, with cranks set 90 degrees apart, which, with only one pump on, will run as high as 30 or 32 amperes. With this load we could never notice the slightest flickering of lights in Redlands, which may be due to the synchronous motor used. To show how an induction motor will act on a fluctuating load, I may say that in the city of Riverside, where they have a recording ammeter in each leg of the circuit for keeping a record of the power used by the city, there is a 30 h. p. induction motor, operating a planing mill, giving a constantly fluctuating load. When that motor is working under an average horsepower of 8 h. p., as shown by the watt meter on the motor, the fluctuation on the ammeter represents a range of over 100 h. p. An induction motor, working on reciprocating apparatus, will cause fluctuations in the current to be multiplied enormously. This is the way I account for the difference between Mr. Eastwood's experience and ours; for even when a check valve becomes stuck in one of these ammonia pumps, there is no flickering in the lights at Redlands.

MR. LIGHTHIPE: There is a great difference between the lifting of water and the pumping of gas, as the gas is compressible. I have always had trouble in pumping water, especially in mining pumps, with anything outside of the triple-plunger pump, probably on account of this long column of water, for every plunger, as it comes into action, has to change the speed of that column. Anything that is compressible, in the way of gas, will ease up the stroke.

MR. EASTWOOD: We have an ice plant of thirty tons capacity, operated by a 150 h. p. induction motor,—also a 50 h. p. induction motor and a 10 h. p. induction motor,—and we find no fluctuation whatever due to the ice plant, which runs twenty-four hours straight through.

MR. RIDLEY: It may be outside of the general trend of the discussion to talk about direct current, but I am rather inclined to bear out what Mr. Ensign says, that the fluctuation would come rather from the alternating current used than from any other cause. The Central Light and Power Company is operating a load that varies; a steady motor load of 150 amperes and a light load of 100, making 250, and it has the Sprague elevators running the load up to a thousand amperes, and we find no difficulty whatever in steadying our lights. We have no complaints from customers of fluctuation in light, and the only precaution that we have in any wise taken has been the diminishing of the fly-wheels of the engines and enlarging the steam ports; but I don't think we can get any better regulation than you could get from water power. The only point I would bring out is that I think this would show that the functions of the alternating current and also the influence of the line would possibly cause a great proportion of the fluctuation that is found in the plants which are operating with alternating machinery.

THE CHAIR: How do you reconcile that with Mr. Eastwood's statement that by using the same type of electric apparatus exactly, but upon different loads,—a compressible gas load and an incompressible water load,—that he finds the results very different indeed; one produces decided fluctuations in his lights and the other does not?

MR. RIDLEY: A compressible load will always save the fluctuation, naturally, but I consider that a Sprague elevator load is an *incompressible* load. [Laughter.]

MR. HUTTON: We are operating a compressor, located about a mile from the sub-station, which is driven by a 100 h. p. motor. Incandescent lights on the same circuit at the end of this line have considerable fluctuation when the compressor is working. It is a single-cylinder machine, but it does not affect the rest of the load outside of that one line.

THE CHAIR: There is one ever-fruitful subject of discussion, and that is the insulator subject, and I have been asked to bring it up, and I should have done so had I not been asked, because I was curious to know from Mr. Eastwood why he substituted glass for porcelain insulators after having used porcelain for some time, and I will therefore call on him first to give us any suggestions that he may have to make from his very fruitful experience on the insulator question.

GLASS OR PORCELAIN INSULATORS?

MR. EASTWOOD: In the matter of insulators, the Folsom-Sacramento plant and ourselves were really pioneers, and in the matter of extreme long distance transmission our plant at Fresno has always held the lead until a short time ago, and, in fact, we now again hold the lead in long distance transmission. When we started in we, of course, took the apparatus which was offered us by manufacturing companies, in the condition that it was then worked out. We have, on our thirty-five mile line, a general electric porcelain insulator which was furnished at that time to both the Folsom-Sacramento and the San Joaquin plants. Of course, in the construction of the line, the insulators were shipped out in barrels, not put through any test, teamed out on the line, and then put up without any particular inspection. The first six months of the use of the line was during the dry season, and we had no difficulty with it, and were feeling quite happy in the belief that we had a pretty well perfected plant, so far as line insulation was concerned. Then came along the fogs of the following winter—the winter of 1896-7. It was a winter in which, in the San Joaquin Valley, the land fogs were of longer duration than had been known in a good many years, and the almost invariable rule is that in our climate there, whenever a low pressure era and a storm comes on, the fog will continue right up to the time of the storm, and then we will have a severe, heavy storm, which, in the course of two or three days, will be followed again by another land fog, which will continue on until the next storm, but it may possibly taper off and gradually disappear with quite a space of time between the fogs. During the heavy storms of that winter we had quite a good deal of difficulty from the burning off of the pins. I went into the subject pretty carefully, and I found that the pin almost invariably burned off at the point where the lower petticoat came in contact with the pin, and that in nearly every case where we had an insulator which burned off it was one that was cracked or defective in some way in the outer petticoat. The water from the rains and fog went down through the body of the insulator and formed a path for the current to the pin, and whenever we replaced any of these insulators where the pin had burned off, we always took great care to select sound ones, and at the same time we coated the pins with P. & B. paint, after being thoroughly boiled in paraffine. Since then we have had no recurrence of the burning of pins.

The matter of insulators has been discussed quite a good deal, and I have been watching very carefully all the discussions and all the different types of insulators that have been brought out, and have, in addition, made experiments in the matter of insulation to our own satisfaction. The conclusion I have come to is that for an insulator, the one main point on which you must be absolutely safe is the matter of having a

dry space between your line and your pin. You must have a roof that will preserve an absolutely dry air space under the insulator in order to have perfect insulation for a high tension current; and for that reason, in making our extension to Hanford, we chose a glass insulator. There has been a great deal of talk about the hydroscopic qualities of glass, and the effect it would have, but the first 10,000-volt transmission line that was built used glass insulators from the first. It is running to-day, and we have never heard of such a thing as a pin burning off, from those people—that is, the Pomona plant. The type of glass insulator that was furnished us by the agents for the Locke insulator was such that I was satisfied it would give satisfaction. We made a very careful visual examination of all the insulators that were put on the line, and we made some static tests on them. These glass insulators are not only cheaper than porcelain, but they are better in every way. There is a good deal of argument as to the matter of strength. We will, in railway or incandescent work carry heavy copper wires on glass insulators that are very light compared with the ones used in transmissions, and yet we think we must have a very heavy, strong insulator to carry a No. 4 or 5 wire in transmission lines. As far as mechanical strength is concerned, our insulators will prove amply strong for any strain that will ever be upon them.

We ran a voltage of 10,000 to Hanford as a matter of experiment, but as it was during the dry season, it was not a fair test. Our insulators are glass, with wooden top pin, and iron bolt and porcelain base, and I think that eventually some such type of insulator as this will be the one that will be finally adopted for all high tension transmission work. We expect, in the latter part of the fall, before the rains come on,

ENSIGN ON INSULATOR TESTING.

when we get our high-tension line in operation, to change the insulators on our main line from the Fresno power-house to the same type of glass insulators that we have on the Hanford line. The porcelain insulators will give us no trouble whatever as long as the weather is dry. Just as soon as the wet weather comes on we will not feel safe in running our 19,000 volts on the porcelain insulators.

THE CHAIR: Bearing on the other side, as I know Mr. Ensign has made a number of very interesting experiments running up to 65,000 or 70,000 volts on porcelain insulators under conditions approximating a very severe driving rainstorm, I would like to have him give the association an account of his work there.

MR. ENSIGN: When we were trying to decide on an insulator for a 30,000-volt line, we heard all the opinions concerning the hygroscopic condition of glass, but we started out prejudiced for glass because glass cannot be punctured under such a voltage. I had satisfied myself that the trouble with the porcelain insulators used on the Folsom and Fresno lines was due to porosity, as could be demonstrated by breaking them open. The burning off of the pins was due to the current passing through the insulator to a point where the pin was wet close up under the lowest point of the threaded portion, at which point the potential, being sufficient to puncture the glaze where the insulator did not protect the pin from being wet, would form a small arc, gradually burning the pin off. But in looking for a glass insulator at that time, I could not find one large enough to stand the potential without the distance from the tie wire to the pin being too near the sparking distance of the potential used, so we were rather forced to the porcelain insulator, strongly guaranteed by the manufacturer. The insulator which we decided upon measures about six and one-half inches across the bottom by about four inches from the tie groove to the bottom of the outside petticoat, and instead of being round on top the top is squared down at the ends of the groove so as to give more of a right angle turn for the tie wire. They are sold to us under a guarantee not to puncture under a test of 70,000 volts. They will stand that voltage in dry weather with the top of the insulator immersed in water to the depth of the tie groove, with a terminal inserted in the pin-fit and the voltage applied to it, the pin-fit and grooves between petticoats being filled with a little water to help find cracks, if there are any. So far we have tested three carloads, which have been found very satisfactory.

TESTING HIGH TENSION INSULATORS.

I find that 66,000 volts, applied between the tie wire and pin, in ordinary dry weather, does not show the slightest tendency to jump around the insulator, although there will be a fine brush discharge in very foggy weather, sometimes jumping around with a sharp report, but not sustaining an arc. As this is four times the strain they will receive upon the line, we feel that it is a very satisfactory test.

The same insulator, mounted in the same manner as used on the line and tested for rain effect, showed a phenomena which has not been mentioned, to my knowledge, in connection with high potential insulators, which is that the height of the outside petticoat above the arm has a large bearing on the leakage and possibility of short circuiting during a rainstorm. In other words, the current seems to prefer to follow the path of the drops to the arm rather than jump across the shorter path to the pin. I took a potential of between 45,000 and 50,000 volts as being a safe voltage with which to determine the size of the insulator as regards rain for a 33,000-volt line. We turned the water on from a garden hose, using a very heavy spray, and gradually raising the insulators by putting porcelain washers on the iron pins, until we reached a height that would show no leakage, either by measuring the energizing current of the transformer or by a visible spark. We magnified the fluctuations of the energizing current by running the current through a water rheostat and connecting a 20 to 1 ratio transformer with the low potential side in multiple with the rheostat, putting a voltmeter on the 2,000-volt side, in that way magnifying the fluctuations of current enormously. These experiments were conducted in the dark, with hydrant water turned on in a thick spray. If the insulators were too close to the arm, there would be a fine, threadlike discharge to the arm from the outer edge of the insulator, and such a discharge would cause the voltmeter needle to swing violently. We found that at 45,000 volts, with the insulator four inches above the arm and a large number of insulators rigged up, we could absolutely detect no leakage. We then took these same insulators and raised them up six or seven inches above the

arm, and raised the voltage to 66,000 volts. The leakage was still inappreciable.

Our method of testing was to place twenty-five inverted insulators in a wood tray with water up to the position of the tie wire, one terminal of the transformer being placed in the water. Mounted on a framework were twenty-five iron pins, which could be dropped at once into the twenty-five insulators. Each of these pins had a spark gap one-sixteenth of an inch long between it and the wiring of the frame. When the insulator did not offer any leakage for the current, there would be no perceptible spark in daylight, but in the dark there would be a fine blue thread; but as soon as the slightest leakage occurred, it would change to a yellow color, and when the insulator would break down to a red flaming arc. I found some curious things in these tests, one of which is that it is of no use to test insulators without having a transformer of considerable capacity. You may get leakage from dust, or a weak insulator, which, while it will not break the insulator down, will not allow the transformer voltage to come up to the required test because of the C. R. drop in the secondary. For instance, with twenty-five insulators in the tray, and gradually raising the potential to say about 15,000 volts, the weakest insulator would break down; if we put another one in its place, perhaps the next time we would get to 20,000 volts and down would go another insulator, until finally we got the whole set of twenty-five to stand the 66,000. But as we would approach the limit, we found we would have to wait a moment or two to give the voltage a chance to rise without applying any more current to the transformer. This was especially noticeable if there was a slight leak, due to dust or dirt on the outside of the insulator. We had on a static voltmeter, which showed us what we were doing all the time. The tests which they made on insulators at Niagara Falls were made with a very small transformer, and some of the small insulators sent us broke down at about 15,000 volts.

We are pretty well satisfied that we have an insulator which will do our work, though I would prefer glass if I could get one large enough, at the same time free from cracks. I met a young man from Telluride, who said the only trouble they had with a five-inch glass insulator was if they shut down from any cause during a rainstorm they could not start up again. They have the same insulator which is used at Yuba River plant and that Mr. Eastwood is also using. I have tested one of these insulators, and the current will jump from tie wire to pin at between forty-five and forty-eight thousand volts. That was too small an insulator for us to use on our 33,000-volt line. When we are reaching these very high potentials, I think our insulators should be large enough to stand double the line potential between pin and wire. The time we decided upon our insulators we could not get a glass one large enough which was perfectly solid.

I have some photographs here showing method of testing which may be interesting, and will pass them around. We punctured between 15 and 17 per cent. of the first that were sent out. They had no method of testing at the factory.

MR. LEE: The glass insulator used on the San Gabriel line is a five and a half inch Locke insulator, weighing about four and three-quarter pounds, and designed for a working voltage of 20,000 volts, and I think the guarantee was that it would stand an insulation test of 40,000, which I think it will do. It is practically impossible to puncture glass that is sound, and it takes about 45,000 volts to go around it. If you take a hammer and hit a porcelain insulator on the head, where the tie wire is, sufficiently hard you will shatter it, and the same is true of glass; but if you only hit the petticoats, as a rule the outer petticoat is the one that will break. One great advantage in the glass insulator is that you can make a visual examination for cracks, which loom up very prominently. All you have to do is to clean the insulator over and you can see the cracks. The "checks" we have noticed in the ones shipped from the factory have not run over 1 per cent.

We understand these checks are due to the annealing of the glass. The question of the glass being hygroscopic is disposed of, because under the most severe conditions, that of a rainstorm, the hygroscopic features are lost sight of, and in dry weather both insulators will get covered with dirt. The Marysville glass insulators stood a test of about 36,000 volts on the line in dry weather.

MR. ENSIGN: I believe the insulator is good for 22,000 volts, and at that voltage perfectly safe in any kind of a rainstorm, but I would certainly limit it to 22,000 volts. There they were running at 40,000, and from my experience it was too small to stand 33,000.

THE CHAIR: I look forward to the time in the near future when we are going to eliminate the large element of copper cost from our calculations, and are going to run up to 50,000 volts as a common thing.

MR. ENSIGN: Our experience has been on one of our lines, and not a great while ago we changed seven insulators in half a mile. It was a shotgun in that case. You could see the marks of the different shot, and the petticoats were all blazed off of one side and on another one all the way round, and there was nothing but the core left, and that was still carrying the wire, which had been thus carried through some severe rainstorms. I have known at least three insulators in the last year that have been that way. They were small insulators.

MR. EASTWOOD: We would be very happy indeed if we had not any more trouble than that which is caused by people shooting off petticoats.

MR. DE SABLA: We have very little trouble with our low voltage, but from what Mr. Ensign is saying about people shooting at insulators, we have both the porcelain and the glass, and we prefer the glass ones, as they are less attractive. All shooting is done at porcelain insulators, and we have not had one single shot at the glass insulators. So I will side with Mr. Lee in favor of glass insulators, on the ground that they are less attractive to the eye.

MR. LIGHTHIPE: Mr. Eastwood's remark about not having any insulators shot makes me remember that the Fresno line is so far away from anywhere that nobody can find it. On the road to the power-house you see the line about once; the rest of it is several miles away from the road off on the top of a mountain. A great many lines run along the county road, and there is where the insulator gets it.

On motion, the Convention then adjourned.

ANENT TRANSFORMER COOLING.

(Communicated after adjournment)

MR. R. S. MASSON: Reading over the "Random Notes" and the discussion which followed at the recent convention of the Transmission Associatian, has given me much pleasure. I should like, however, to offer a few remarks on some points of the same.

The quiet prosecution of high voltage experiments in 1896 at 60,000 volts was done with Westinghouse transformers and lightning protecting apparatus, by Westinghouse men, in conjunction with Messrs. Nunn brothers, of Telluride, who have now built the Provo plant. Much credit is due to the Nunn brothers for producing the facilities, and much also to the Westinghouse company for producing the necessary and successful apparatus.

The conclusion drawn that manufacturing companies are afraid to build and guarantee high tension transformers, since they will not assume "responsibility for loss of business or other damages resulting from breakdowns' is hasty. No company will assume such responsibility for a 110-volt generator, and yet they are not afraid to make and guarantee them.

One might easily conclude from the contention on the subject of high efficiency versus good insulation, that the trans-

former having lowest efficiency would be the best to use. There are advantages in high efficiencies, however, and insulation may be made sufficient for each specific case without indefinite increase in dimensions. After sufficient insulation is applied, there is no objection to improving the efficiency of the transformer.

I am interested in the information conveyed to me that line loss at 60,000 volts is twenty-five per cent. of what it is at 30,000 volts. The copper loss would be twenty-five per cent. if the power factor remained the same, but the leakage would be increased to twice as much or more. Capacity and self-induction would change, and the total loss at 60,000 volts would be far above twenty-five per cent. of the loss at 30,000 volts.

Regarding the fullerboard versus mica conclusions, there is a lack of data in the hypothesis. Mica has its place and does not conflict with fullerboard.

I cannot follow the arguments about the uneven temperature produced by a water-coil "running through to the bottom." We want an uneven temperature, or we do not cool the oil. If hot oil rises around the transformer we wish to cool it, and after it has fallen to the bottom of the case, it is ready to rise again and continue to take heat from the transformer. This means uneven temperature; therefore let us use the coil going "through to the bottom."

The idea of protecting the entrance of wires into a building by glass or marble panels is excellent. I shall use it hereafter. The insulator and pin statements agree with the conclusions reached by the Association at Santa Cruz in 1897.

Two classes of transformers are in use. They are related by the nature of their work, but require entirely different considerations and constructions. Much of the discussion showed that experience from one class was taken as evidence for the other. A street transformer of a twenty-light capacity at 2000 to 100 volts, filled with transil oil accumulating dust, and having its terminals, and possibly the case, covered with oil and dust, is in one class. A station transformer of 100 kilowatts capacity at 15,000 to 2000 volts, filled with clear, transparent mineral seal oil, is in the other class. This Association was presumably discussing the latter class. Most of the experience mentioned was undoubtedly in the former class, and does not apply to the latter.

"Bridging of impurities" in a flood of circulating oil where solid insulation stands between coil and coil, layer and layer, turn and turn; "trouble with the terminals coming out of the case," which no one has; oil in the coil forming a "bridge on the magnetic line," suggesting a novel idea—the magnetic property of oil; "impurities going into the very center of the coil through paper, linen, and shellac;" a transformer keeping cleaner with an air-blast throwing moisture and sand into it, than it would in an iron case covered with oil; an air-blast transformer requiring "no external device"—except a blower and motor air ducts and air pump for cleaning, and a few other items; the fact that you can get at all parts of an air-cooled transformer, especially the air ducts through the core and coils, without taking it apart; and that Mr. Eastwood found "large cakes of dust," and the question, "did he find them all?"—these points all show that the statement "I am not in position to debate" was correct.

The General Electric Company "are drifting away from oil." When did they use it? Not since they built some of their earliest high tension transformers—those on the Folsom-Sacramento transmission. It takes it a long time to drift. There must be a restraining force.

The gentleman did not observe that low efficiency of transformers means increased heating—a very bad feature.

I have never experienced the trouble mentioned about finding a fault; nor did oil fill up all of the punctures. When it did, I was satisfied, since I knew nothing about it. When it did not fill the punctures, there was plenty of evidence of the whereabouts of the trouble, such as lumps of melted copper.

Air cooling was said by one gentleman to be "precluded by the necessity of having a motor and fan." At Marysville the same gentleman installed a motor and pump to get water. True, the reservoir used acts for fire protection, but fire reservoir pumps run one or two days in a year; this one runs all the time. If it stops, the plant stops after the reservoir runs dry. Fires which tend to be disagreeable would naturally come at this time, leaving the station without protection. If you buy water, it is an expense. Air is cheap. For sub-station work, air-cooled, oil-insulated transformers have many advantages. At Santa Cruz, there is no attendant at all on duty at the sub-station. Power and light are used day and night, and during two years' operation, no one has ever gone into the transformer room except to take a look around. There was no water to stop, no pump to run, no fan to look after, and they did not use the fire hose to clean out a pipe. They are self-operating.

The Central California Electric Company has had some trouble; but this line is the longest 15,000-volt line which has operated for any considerable time. Length of line and amount of voltage make a considerable difference.

If insulating material is perishable, it should last longer under oil than in an air and sand blast of changing humidity. I do not agree with the "perishable goods" remark.

I am surprised to know that the General Electric air-cooled transformer, with its excellent conditions, should melt solder at its terminals, and that "the heating of twenty-four-hour service will cause a little solder to drop out," and that it is necessary to re-solder the connections at intervals.

The capacities for overloads, etc., are qualities of transformers, not types of transformers.

The President's conclusion that oil-insulated, water-cooled transformers were in favor, was reached without any arguments being presented on the type of oil-insulated, air-cooled transformers. I believe if he will read over all of the points made, leaving out the unsound and guessed-at points, and keep in mind all the while the oil-air transformer, he will see that this type has more of the good features and less of the bad ones than any other type. For sub-station work where the attendance is not continual and small units are used, the cost is the same as for water-cooling, and this type is excellent. At generating stations or large sub-stations where large units are used, a slight decrease in the cost per kilowatt is important and water-cooled, oil-insulated transformers are the best practice.

CONCERNING THE QUIMBY PUMP.

(Communicated after adjournment)

MR. CHARLES C. MOORE: Your secretary advises me that during the discussion which followed the reading of Mr. Richards' paper on centrifugal pumps, information was asked for concerning the Quimby pump, and in order to show how far the pump in question is adapted for use from electrical circuits, I may state that the Quimby pump for direct connection to electric motors has a very high efficiency against a wide range of pressure, because: (1) the power is applied direct; (2) the thrust due to the back pressure of the column of liquid in the delivery pipe is perfectly balanced, as the delivery opening is placed in the middle of the cylinder and the endwise pressure upon the screws in one direction is exactly counterbalanced by a like pressure in the opposite direction; (3) the absence of rubbing surfaces and consequent absence of internal friction, space enough being left between the screw and the cylinder and between the faces of the intermeshing threads to allow a close running fit, without actual contact; (4) the rotary motion of all moving parts and the

continuous flow of the liquid delivered being free from pulsation.

That there is realized the high efficiency which the above would lead one to expect, is shown by the following test of a Quimby pump made by J. H. Clark, of the Power Mining Department of the General Electric Company at Schenectady, N. Y. The pump was direct connected to a 200-volt multipolar motor running at 1,100 revolutions per minute, and the results of the test are as follows:

Total Feed and Suction Pounds.	H. P. Input.	Gallons per Minute.	Eff. Combination.	Eff. Pump.	Eff. Motor.
14.6	5.4	274	43.0	70.0	61.0
22.6	7.0	267	50.3	72.2	69.5
42.6	10.6	243	59.1	73.6	78.3
62.6	14.3	236	60.0	73.0	83.2
82.6	18.2	227	60.0	71.0	83.5
102.6	21.9	218	59.5	67.8	87.2
122.6	26.6	208	55.9	61.0	88.2
142.6	31.2	201	53.5	60.0	85.8

These pumps have been extensively used for various classes of work, being adapted to general pumping, irrigating, or either the pressure tank, gravity, or direct pumping electro-hydraulic operation of elevators, and owing to the absence of valves it handles thick liquids easily and efficiently.

(Communicated after adjournment.)

MR. F. O. BLACKWELL: I have read with interest THE JOURNAL OF ELECTRICITY giving a discussion upon high tension transformers which occurred at the Second Annual Convention of the Pacific Coast Electric Transmission Association, and, referring to air-blast transformers, it is a mistake to speak of them as having an air-insulation. While the small air ducts between the coils do, to a certain extent, increase the voltage required to jump between the primary and secondary coils on transformers of high potential, the resistance of this air gap and the surface insulation between coils is practically negligible. We believe that the insulation on our coils is sufficient to stand the high pressure without trusting at all to the spaces between them. Consequently there can be no serious reduction in the strength of the insulation of such a transformer due to an accumulation of dirt in the coils. I am not afraid of the accumulation of dust until it reaches a point which will seriously impede the circulation of air through the transformer.

Gas

PROPERTIES AND DANGERS OF ACETYLENE.*

THE lighting power is about fifteen times that of coal gas, the heating power more than twice. Every burner has a best pressure, generally from 1.2 to 1.6 inch water. A new Bray 0000 burner, using 0.95 cubic foot per hour, gives 43¼ candles, with a pressure of 1.28 inch; but the burner is hopelessly blocked in twenty hours (Weber). Billwiller's burners (two converging jets at right angles to one another dragging air with them) work for months on end, giving 26 candles for 0.77 cubic foot per hour. The temperature of combustion should be very high, 2,500° C.; but it is lower (900° C.) than that of the Welsbach mantle (1400° C.). The flame of acetylene is a succession of minute explosions analagous to a discharge of rockets. At the German Mint an acetylene bunson flame rapidly got up temperatures above 1500° C., and melted in thirty minutes a quantity of nickel which had previously taken eighty-five minutes. The flame is bright and very actinic (photographic), the spectrum is very like that of sunlight, and colors are distinguishable in the light. Acetylene and air are explosive within a very wide range of proportions, from 5 to 62 per cent. (Le Chatelier), 3 to 72, or even 80 (Bunte), instead of 8 to 30 as in the case of coal gas. The fiercest explosion takes place with 1 acetylene to 9 air. Pure acetylene at the atmospheric pressure decomposes at 750° C.; a mixture of at least 35 per cent. of air with acetylene decomposes at 480° C. (Le Chatelier). At a works in Veszprem, Hungary, the yield at which is 5,250 cubic feet per hour, the temperature is kept below 30° C., so as to keep down impurities. The phosphoretted hydrogen goes up to 0.95 per cent., and the arseniuretted hydrogen up to 1.71 per cent. The light is 8.77 candles for 0.3 to 0.325 cubic foot per hour; and it has been noted there that acetylene dried over carbide, very rapidly dries up the joints of the pipes, so that these become leaky.

PROPERTIES.

Compression of acetylene increases the rapidity of propagation of combustion, and lowers the kindling temperature. At two atmospheres it is explosive, even in a tube 160 inches long and 0.8 inches in diameter (Berthelot). Gerde's experiments in acetylene at six atmospheres show how heat applied to a pipe causes an explosion of the gasholder 60 inches away, the pipe being 0.2 inch in diameter. At 0° C. and 26 atmospheres pressure, 855 litres of gas become 2.2 litres of liquid, of specific gravity 0.45 (water being 1). The liquid is extremely expansible, so that we should never fill a cylinder with liquid acetylene to more than three-tenths its capacity. Acetylene is readily frozen to snow. At 15° C. the pressure exerted by liquid acetylene is 38 atmospheres; at 38° C. it is 68 atmospheres; but beyond this temperature (36.9° according to Ansdell and Gerde) it is not possible for the acetylene to remain liquid; and there is no recipient strong enough to stand the pressure induced by its reassuming the gaseous condition, for the gas produced would be at a pressure above 6000 atmospheres, and the too venturesome experimenter would run a risk of—forgetting what the observed pressure was. The pressure becomes so high because of the heat liberated on the break-up of the endothermic compound. One cubic foot of liquefied acetylene represents 360 cubic feet of acetylene gas; one cubic foot of carbide represents 660 cubic feet of gas; the respective weights are 28⅛ and 137½ pounds per cubic foot. But the question seems to be settled so far as regards liquefied acetylene, which is now prohibited by law in most countries of Europe. Acetylene dissolved in acetone under pressure is also complicated; and recourse must be had to the carbide itself for the lighting of vehicles, etc., so that we have to consider the best means of overcoming the difficulties incident to producing the acetylene as it is required.

COMPRESSED AND LIQUEFIED.

M. Bouvier then gives a list of twenty-nine accidents due to acetylene during 1896 and 1897, and resulting in nineteen deaths. The dangers incident to producing acetylene as it is required seem to be the following: 1—Local heating of carbide to a red heat, when not completely covered by water, in a vessel from which the gas is not allowed freely to escape; the compressed gas is highly explosive under such conditions. 2—Irregular rushes of gas when the lime falls off the carbide (bicycle lamp explosion at Lyons). 3—The easy kindling of the gas, by a soldering iron or a cigarette, 480° C. 4—The extreme rapidity of propagation of flame in an explosive mixture of air and acetylene, especially under pressure. 5—The wider limits of explosibility. 6—The slow diffusion between escaped acetylene and the surrounding air, the two gases having very near the same specific gravity, acetylene, 0.91, and air 1.00. 7—The rapid permeability of rubber by acetylene. 8—The shattering character of the explosion of mixtures of air and acetylene. 9—The circumstance that compressed acetylene of which a certain quantity near the mouthpiece has become mixed with air will go off as a whole if that small quantity of the mixture be fired, for the irritation is enough to cause decomposition and evolution of

DANGERS.

*Abstract of a paper read before the Societe Technique du Gaz, 1898, by M. Ad. Bouvier.—"The Gas World," London.

heat which travels through the whole bulk. 10—The spreading backwards of an explosion in the same way where local heating is induced by allowing the gas to rush at too high a pressure through too small an aperture. 11—The accidental impurities of acetylene, siliciuretted and phosphorretted hydrogen and ammonia.

The risks then, are undeniable. Can they be avoided? There are only two methods of using acetylene other than pure acetylene. These are dissolved acetylene and diluted acetylene. As to the former, acetone dissolves, practically, 200 times its volume at 12 atmospheres pressure; about one-third the gas that may be obtained from an equal bulk of carbide. But it seems that the running back of a flame might do terrible havoc, for the acetylene going off will get up a high pressure, and at 20 atmospheres the acetone would go off too. In any case 12 atmospheres pressure means a heavy recipient. As to dilution, acetylene has been diluted with air, even by lecturers on the subject, in the United States. Then came nitrogen, but of this nothing much seems to have come. Then came carbonic acid, which is a promising idea (Kruger, Charlottenburg, 1895; Goodwin, Dublin). The Paris municipal laboratory experiments settled it that 10 or even 20 per cent. of carbonic acid affects the lighting value of acetylene by less than 10 per cent. of its amount. It seems as if the carbonic acid played the same part as the thoria in a mantle does in relation to the ceria, according to Dr. Bunte's explanation. Carbonic acid greatly reduces the risk of explosion, but it does not seem to be known what its effect is as regards the deposition of carbon in the burners. It enables acetylene to be used in motors, by diminishing the violence of the explosion. One inventor worked up dry carbide, a dry bicarbonate, and a dry acid, so that the product, which he called "acetylene," might give off a mixture of acetylene and carbonic acid; but nothing seems to be heard of this now.

SAFEGUARDS.

M. Bouvier went on to discuss the use of acetylene mixed with coal gas and with oil gas, and the conclusions he reaches are that acetylene with oil gas is practical; acetylene with carbonic acid is probably so; acetylene alone is risky; and portable acetylene lamps may actually be considered to be dangerous.

Traction

ELECTRIC TRACTION DISCOUNTS STEAM HAULAGE.

A STRIKING instance of economy in actual money and elimination of trouble and delay induced by supplanting a steam haulage service with electric traction, is afforded by the installation recently made by the General Electric Company for the Arlington Mills, Lawrence, Mass. These mills have about two miles of track running from the main line of the Boston and Maine Railroad into the yards and throwing off spurs into the alleys between the different buildings. Previous to the change to electrical service, the haulage of the entire output of the mills to the main line, the haulage of the material from building to building, as well as the necessary switching about the yards, was done by a steam locomotive rented from the railroad. For this service the Arlington Mills paid an annual rental of several thousand dollars, and were, moreover, frequently put to great inconvenience and delay on account of the unavailability at times of any locomotive.

The successful results obtained with electric factory locomotives by other mills in New England, notably at Whitinsville, Mass., and Taftville, Conn., attracted the attention of the managers of the Arlington Mills to the question of electric haulage which they took into serious consideration. As every case in which electric traction has been adopted in factories showed an improved service, as well as an actual money economy, electricity as a motive power was decided upon.

The electrical installation consists of a small generating plant and two electric locomotives, one of the box type and the other a platform car. The generating plant consists of a standard GE. seventy-five kilowatt, 500-volt railway generator driven by belt from a high speed engine. The generator readily answers all calls upon it, with absolutely no heating or sparking, although it is occasionally subjected to very heavy overloads when both cars are handling a train of more than the usual number of loaded cars.

The box car locomotive used for hauling material about the yards is equipped with two GE. 800-27 horse-power motors and series parallel controllers. The platform locomotive is used to haul trains of loaded cars, and its equipment consists of two 50 horse-power GE. 1200 motors with the necessary series parallel controllers. In hauling heavy trains it is assisted by the box car locomotive, and together, they are

A BOX CAR LOCOMOTIVE AT THE ARLINGTON MILLS.

able to handle trains of thirty to forty empties, or twelve to fourteen loaded cars, with comparative ease and celerity. To give the necessary adhesion to the more powerful locomotive to enable it to handle heavy loads, about six tons extra is placed on the platform.

Perhaps the most interesting feature is the comparison between the cost of the electric plant and the expense formerly entailed by the use of the superceded steam locomotive. No more men are employed about the electric locomotive, the labor cost has not risen, and the consumption of coal is scarcely felt on the main plant. Furthermore, the plant being always ready, cars may be shifted at any time during the day or night.

The new system is thus both economical and advantageous and the appreciation of the Arlington Mills is, perhaps, best shown by the fact that a second platform locomotive is shorly to be added to the haulage plant.

Industrial

In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

TWO MAMMOTH CONTRACTS.

MORE than passing interest is always attached to record-breaking achievements, and the Walker Company, of Cleveland, Ohio, is to be tallied with two counts on this score for remarkable contracts it has secured during the past six weeks, the first of which is said to be for the largest order for alternating current machinery ever placed at one time, and the second is for the largest railway generator ever built.

The first contract is from the Union Carbide Company, of

Chicago, for the building and delivery of twenty 500 horse-power alternating current generators, single phase, sixty cycles, to deliver a current of 2500 amperes at 200 volts. Besides these, there will be five 100 horse-power direct current generators as exciters, and a complete switchboard for all of these machines. The spot selected for this mammoth plant, which is to be run entirely by water power, is at the falls of the Soo at Sault Ste. Marie. The Union Carbide Company has acquired rights of manufacture of calcium carbide for the United States and will have its main works at Sault Ste. Marie. The carbide is at present manufactured at Niagara Falls, the electric power necessary being supplied by the Niagara Falls Power Company. The output of the Niagara plant is about ten tons per day, while that of the works at the Soo will be 100 tons per pay. The works are to be built for the accommodation of forty generators and forty electric furnaces, where the lime and carbon are fused into calcium carbide, the twenty generators in this first contract being but the initial order.

The second contract is with the Boston Elevated Railway Company, under which the Walker Company is to furnish a generator capable of delivering in regular service 6000 amperes at a voltage of 550, and capable of delivering upon overload about 9000 amperes. The generator will be rated at 3000 kilowatts, and will be direct-connected to a 5000 horse-power engine. It will have twenty-four poles, will stand twenty feet high, and will weigh 300,000 pounds. Its armature will be fifteen feet in diameter, and will alone weigh 125,000 pounds. The commutator will have 1200 bars, each two feet long and four inches deep, and the armature shaft will be three feet in diameter. The unit will run at 75 revolutions per minute. The machine will have an adjustable compound winding, by which its rate of over-compounding may be changed at will to provide for variable loads at different times of the day. Altogether this machine will represent a development in railway practice to higher things than have yet been attained, and the best results are expected. The contract was placed with the Walker Company after a careful inspection by the engineers of the Boston Elevated Railway Company of the large Walker generators in the Kent avenue station, in Brooklyn, which have been giving very good service. These generators were put through some of the severest tests possible to devise, such as breaking circuit instantly on full load, and no trouble whatever was found, the brushes even remaining practically sparkless at the break.

The Wybro-Hendy Company, 38-44 Fremont street, holds the Pacific Coast agency for the Walker Company.

A MERITORIOUS INCANDESCENT LAMP.

WHILE much attention has been recently given to the development of the enclosed arc lamp, equal, if not not greater study has been devoted to the further perfection of the incandescent lamp, not only with the view of making it more serviceable and efficient, but in order that it may effectually compete with the arc lamp in the illumination of interiors. As a result, some incandescent lamps have reached a high degree of perfection, and among these is the "Pacific" incandescent lamp sold through the agency of the Pacific Coast Electric Company of 1145 Market street, San Francisco.

The "Pacific" lamp is one concerning which much might be said, but so extravagant are the claims put forward by many incandescent lamp manufacturers that the makers of the "Pacific" lamp are perfectly satisfied to allow it to stand on its own feet, as it were, knowing full well that its merits will bear it successfully through any competitive test with any other incandescent lamp on the market. Efficiency, life and first cost are the factors determining the serviceability of an incandescent lamp. The life and efficiency of the "Pacific" lamp will soon be declared by any one who gives it a trial to be all that is claimed for it, while the selling price, as is shown in the advertisements is as low as any lamp on the market, and much lower when the question of serviceability is taken into consideration. It is a lamp that no station manager, or isolated plant, or incandescent light consumer can afford to pass by without a trial.

The Pacific Coast Electric Company is, by the way, a consolidation of the Pacific Coast Electric Company, formerly of 241 Powell street, San Francisco, and the California Electric Supply and Construction Company, which, under the management of E. H. Forst, has placed some of the largest and finest house service and incandescent installations in California. Mr. Forst has been chosen manager of the new concern, which is destined to be an important factor in electrical affairs of the coast.

WORTHINGTON PUMPS ON THE COAST.

The Pacific Coast agency of Henry R. Worthington, the well known manufacturer of pumps of every description, has been transferred from the Crane Company, and the business is now being handled as a branch office under the management of W. P. Eichbaum, with headquarters on the third floor of the Mills Building, San Francisco.

The Woodill & Hulse Machine and Electrical Works, of 108 West Third street, Los Angeles, has secured the contract for all the electrical work to be placed in the new Stimson building now in course of construction in that city.

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